

**LEARNERS' AND EDUCATORS' PERCEPTIONS OF CELL-PHONE USE IN THE
TEACHING AND LEARNING OF PHYSICAL SCIENCES IN MORETELE HIGH
SCHOOLS OF THE BOJANALA DISTRICT IN SOUTH AFRICA**

by

Godfrey C. Muyambi

Student No: 45362688

Submitted in accordance with the requirements for the degree of

Master of Education

in the subject Natural Science Education

at the

University of South Africa

Supervisor: Prof N Nkopodi

DECLARATION

I declare that the thesis “Learners’ and educators’ perceptions of cell-phone use in the teaching and learning of Physical Sciences in Moretele high schools of the Bojanala district in South Africa” is my own work and that all the sources I have used or quoted have been acknowledged by means of complete references.

(MR) G. C. MUYAMBI

DATE

ABSTRACT

This study investigated learners' and educators' perceptions of cell-phone use in the learning of Physical Sciences. The theory underpinning the study was the adoption model based on the theory of reasoned action (TRA) and the theory of technology acceptance (TAM). A mixed-method approach was applied. The instruments used to collect data were questionnaires, focus groups and interview schedules.

The strategies used to analyse data were thematic analysis, cluster analysis and factor analysis. Data were coded and organized into descriptive themes, and differences between variables were noted. A mixed-gender sample of science learners aged 15 to 22 years and educators participated in the study. Both the qualitative and the quantitative data revealed that the learners and the educators had predominantly positive perceptions of the use of cell phones in the learning of Physical Sciences.

KEY TERMS: mobile learning; perceptions; attitudes; adoption; readiness; digital literacy; learner; educator; high school.

DEDICATION

Glory be to GOD for his Love and Guidance.

To my wife Ketai and three children Mufaro, Munenyasha and Tanaka, I dedicate this write-up. You make me flourish even in times of hardship.

ACKNOWLEDGEMENTS

I would like to extend my heartfelt gratitude to God, my Creator, for His protection, guidance and constant love.

Next, I am greatly indebted to Professor Nkopodi Nkopodi, my supervisor, for the exceptional scholarly advice, efforts and guidance he rendered me throughout my study. You were more than a supervisor in taking me through all those extra miles.

Furthermore, I would like to express my deepest gratitude to my wife Ketai and our three children, Mufaro, Munenyasha and Tanaka. It was a trying time for me, missing some of the fatherly bonding time during the writing of the dissertation. Though I used some of your time, you were resilient, loving and encouraging throughout. Your efforts enabled me to achieve this end.

My sincere gratitude also goes to Dr M Chirove for the extra mile he went in editing my dissertation. Your efforts and support took me to this new level of achievement.

To my colleagues, the school principals, teachers and learners who provided data and other forms of assistance towards the completion of this research, you are stars in my life.

To my loving friends Mabikahama T, Dr Magwiro A, and Zhoua T, I am very grateful to you for standing beside me, assisting and guiding me. Stay blessed forever.

Lastly, my profound gratitude goes to the University of South Africa for awarding me a research bursary, which allowed me to pursue and complete this work.

ABBREVIATIONS AND ACRONYMS

ACE	:	Advanced Certificate in Education
CAPS	:	Curriculum and Assessment Policy Statement
CDE	:	Centre for Development in Education
DACST	:	Department of Arts, Culture, Science and Technology
DoE	:	Department of Education
Eskom	:	Electricity Supply Commission
ICT	:	Information and Communication Technology
NGO	:	Non-governmental organization
NRF	:	National Research Foundation
NSMSTE	:	National Strategy for Mathematics, Science and Technology Education
NW	:	North West province
PDA	:	personal digital assistant
SA	:	South Africa
SPSS	:	Statistical Package for Social Sciences
TAM	:	Technology Acceptance Model
TIMSS	:	Third International Mathematics and Science Study
TRA	:	Theory of Reasoned Action
UNESCO	:	United Nations Educational, Scientific and Cultural Organization

CONTENTS

Declaration.....	i
Abstract	ii
Dedication	iii
Acknowledgements.....	iv
Abbreviations and acronyms.....	v

Chapter 1

Introduction and Purpose of the Study

1.1	Introduction	1
1.2	Background to the study.....	1
1.3	Justification of the study.....	3
1.4	Statement of the problem	6
1.5	The research question	7
1.5	Research sub-questions	8
1.6	Aim of the research	8
1.7	Assumptions	9
1.8	Definitions of key terms	9
1.9	Chapter summary and structure of dissertation.....	10

Chapter 2

Review of Related Literature

2.1	Introduction	11
2.2.1	Theory on adoption of technology and mobile service	11
2.2.2	The theory of reasoned action (TRA).....	12
2.2.3	The technology acceptance model (TAM).....	15
2.3	Empirical evidence	17
2.3.1	Learners' perceptions of cell phones in teaching and learning	18
2.3.2	Educators' perceptions of cell phones in teaching and learning	20
2.3.3	Use of cell phones in teaching and learning.....	24
2.3.4	Delivery of Physical Sciences lessons in high schools	25
2.3.5	Impact of cell phones on teaching and learning	27
2.3.6	Attributes of mobile phones in Physical Sciences learning	28

2.3.7	Limitations of mobile phones in learning Physical Sciences	30
2.3.8	M-learning (mobile learning) and e-learning (electronic learning).....	31
2.4	Chapter summary	32

Chapter 3

Research Methodology

3.1	Introduction	33
3.2	The research design	35
3.2.1	Descriptive design	36
3.2.2	Quantitative and qualitative approaches.....	39
3.3	Population and sample.....	40
3.4	Research instruments.....	41
3.4.1	Questionnaire.....	42
3.4.1.1	Reliability	44
3.4.1.1.1	Learners' questionnaire	44
3.4.1.1.2	Educators' questionnaire	45
3.4.2	Convergent and discriminant validity	46
3.4.3	Learner focus-group interview	48
3.4.4	Educators' interview.....	50
3.4.4.1	Validity of the interview.....	52
3.5	Data-collection procedure	52
3.5.1	Administration of the research instruments.....`	53
3.5.1.1	Questionnaires	53
3.5.1.2	Focus-group interviews	53
3.5.1.3	Face-to-face interviews	54
3.6	Interview etiquette.....	54
3.7	Ethical measures.....	55
3.7.1	Informed consent and assent	55
3.7.2	Right to privacy	56
3.7.3	Protection from harm.....	56
3.7.4	Honesty.....	56
3.8	Chapter summary	57

Chapter 4

Data Presentation and Analysis

4.1	Introduction	58
4.2	Presentation of data	58
4.3	Outline of the pilot study	59
4.3.1	Ethical procedures for the pilot study.....	59
4.3.2	Pilot study findings and discussion	60
4.3.2.1	Quantitative and qualitative findings of the pilot study	61
4.3.3	Quantitative findings from qualitative data.....	62
4.3.4	Conclusion.....	63
4.4	Main study summary table	63
4.4.1	Analysis of learners' responses to closed-form questionnaire	63
4.4.1.1	Factor analysis results	63
4.4.1.2	Analysis of learners' responses to closed-form questionnaire	78
4.4.2	Analysis of educators' closed-form questionnaire responses.....	89
4.4.2.1	Factor analysis.....	89
4.4.3	Comparison of learners' and educators' perceptions of cell-phone use (t-test)	109
4.4.4	Analysis of open-ended questionnaire and interview.....	110
4.4.5	Analysis of open-ended responses from questionnaires.....	112
4.4.5.1	Learners' perceptions of cell-phone use in the teaching and learning of Physical Sciences	112
4.4.5.1.1	Positive perceptions.....	112
4.4.5.1.2	Negative perceptions	114
4.4.6	Analysis of focus-group interview responses from the learners	115
4.4.6.1	Learners	115
4.4.6.1.1	Positive perceptions.....	115
4.4.6.1.2	Negative perceptions	116
4.4.7	Analysis of educators' interview	117
4.4.7.1	Perceptions of use of cell phones	117
4.4.7.1.1	Positive perceptions.....	117
4.4.7.1.2	Negative perceptions	118
4.4.8	Positive perceptions on the implementation of cell- phone use	119
4.4.9	Summary of discussions of findings	119

4.4.10	Discussion of results in relation to the literature	120
4.4.11	Chapter summary	121

Chapter 5

Summary, Conclusions and Recommendations

5.1	Introduction	123
5.2	Summary of the study.....	123
5.3	Conclusions	125
5.4	General recommendations	126
5.5	Recommendations for future studies	127
5.6	Limitations of the study.....	127
5.7	Reflections on the findings, and conclusions	128
References.....		129

Appendices

Appendix I:

Letter to the Department of Education requesting permission to conduct research	148
---	-----

Appendix II:

Letter to principals of schools requesting permission to conduct research	150
---	-----

Appendix III:

Letter to prospective participants.....	152
---	-----

Appendix IV:

Consent to participate in the study.....	156
--	-----

Appendix V:

Letter requesting parental consent for participation of a minor in the research project	157
---	-----

Appendix VI:

Letter requesting learner's assent to participate in the research project	160
---	-----

Appendix VII:

Letter requesting educator to participate in an interview.....	162
--	-----

Appendix VIII:

Covering letter for learners' Questionnaire	165
---	-----

Appendix IX:	
Questionnaire for learners.....	167
Appendix X:	
Covering letter for educators' questionnaire.....	172
Appendix XI:	
Questionnaire for teachers	174
Appendix XII:	
Covering letter for focus-group interview schedule for the learners	179
Appendix XIII:	
Focus-group interview schedule for the learners	181
Appendix XIV:	
Covering letter for educators' interview	182
Appendix XV:	
Interview schedule for the educators	184
Appendix XVI:	
Research Ethics Clearance Certificate	185
Appendix XVII:	
Permission letter from Moretele Department of Education.....	186

List of tables

Table 1.1:	
National Physical Sciences key indicators (2011-2014).....	5
Table 1.2:	
Grade 9 learners' average performance in Mathematics and Science	6
Table 3.1:	
Extracts of reliability coefficients on four factors that represent learners' perceptions of cell-phone use	44
Table 3.2:	
Average reliability statistics for the four factors.....	45
Table 3.3:	
Average reliability statistics from the educators' closed-form questionnaire	46
Table 3.4:	

Extract of matrix of correlations between factors.....	47
Table 4.1	
Pilot study	60
Table 4.2:	
Summary of findings of the pilot study	61
Table 4.3:	
KMO and Bartlett's test	63
Table 4.4:	
Communalities	64
Table 4.5:	
Principal component analysis	66
Table 4.6:	
Rotated component matrix	68
Table 4.7:	
Descriptive statistics (learners): frequency and percentages	72
Table 4.8:	
Item statistics	76
Table 4.9:	
Summary item statistics	78
Table 4.10:	
What is your gender?	79
Table 4.11:	
What is your age?.....	80
Table 4.12:	
Do you have a cell phone with internet services?	81
Table 4.13:	
Do you use a cell phone for Physical Sciences learning?	81
Table 4.14:	
If “Yes”, how many times a week do you use a cell phone for Physical Sciences Learning?	82
Table 4.15:	
How many times a week do you receive SMS comments from your teacher?.....	83

Table 4.16:	
Do you think mobile Physical Sciences Programme helps you to pass Physical Sciences?	85
Table 4.17:	
What I like most about cell phones with internet services in Physical Sciences learning is:.....	85
Table 4.18:	
Do you think cell phones with internet services should be used for Physical Sciences learning in all schools?.....	86
Table 4.19:	
Communalities	89
Table 4.20:	
Total variance explained	91
Table 4.21:	
Rotated component matrix	94
Table 4.22:	
Descriptive statistics (educator): frequency and percentages	97
Table 4.23:	
Item statistics	101
Table 4.24:	
Summary item statistics	102
Table 4.25:	
Gender	103
Table 4.26:	
Age	104
Table 4.27:	
Highest qualification in sciences	105
Table 4.28:	
Do you have a cell phone with internet services?.....	105
Table 4.29:	
Do you use a cell phone with internet services for Physical Sciences teaching?	105
Table 4.30:	
How many times a week do you send SMS comments to your learners?	106

Table 4.31:	
Do you think cell phones with internet services help your learners to pass Physical Sciences?	107
Table 4.32:	
Do you think cell phones with internet services should be used for Physical Sciences learning in all schools?.....	107
Table 4.33:	
Do you think cell-phone learning can cause indiscipline in schools?	107
Table 4.34:	
Group statistics.....	108
Table 4.35:	
Independent sample test	109
Table 4.36:	
Coding scheme for the perceptions of cell-phone use	110
Table 4.37:	
Classification of perceptions of cell-phone use	111

List of figures

Figure 2.1:	
Theoretical model on user acceptance of information technology	11
Figure 2.2:	
Theory of reasoned action (TRA)	13
Figure 2.3:	
Technology acceptance model (TAM)	16
Figure 2.4:	
M-learning, e-learning and d-learning Interrelationship.....	31
Figure 3.1	
Research design (Mixed methods)	34
Figure 3.2:	
Research onion depicting an overview of Chapter 3	35
Figure 3.3:	
Explanatory sequential research design	37

Figure 4.1:	
Mean perceptions	62
Figure 4.2:	
Numbers and percentages of combined mean of educators and learners	62
Figure 4.3:	
Scree plot showing number of components and eigenvalues of the correlation matrix	67
Figure 4.4:	
Bar graph of average total frequency and percentages of learners' responses	76
Figure 4.5:	
Numbers and percentages of learners according to gender	79
Figure 4.6:	
Percentage of learners in each age group.....	80
Figure 4.7:	
Percentage of learners with cell phones with internet services.....	81
Figure 4.8:	
Learner frequency and percentages of cell-phone use	82
Figure 4.9:	
Frequencies and percentages of teacher-learner communication per week.....	84
Figure 4.10:	
Do you think cell phones with internet services should be used for Physical Sciences learning in all schools?.....	87
Figure 4.11:	
Comparison of teachers' and learners' Perceptions of disadvantages of cell-phone use in teaching and learning Physical Sciences	88
Figure 4.12:	
Scree plot	93
Figure 4.13:	
Frequency and percentages	104
Figure 4.14:	
Number of times per week educators help learners by using cell phones	106

CHAPTER 1

INTRODUCTION AND PURPOSE OF THE STUDY

1.1 INTRODUCTION

This chapter provides a synopsis of the entire study, which investigates learners' and educators' perceptions of the use of cell phones in the teaching and learning of Physical Sciences in Moretele high schools of the Bojanala district in South Africa. The key elements for this chapter include the background to the study, justification of the study, statement of the problem, research question and sub-questions, aim of the research, assumptions, definition of key terms, and chapter and content analysis.

1.2 BACKGROUND TO THE STUDY

Most high schools in South Africa experience a high failure rate, particularly in Physical Sciences and Mathematics (Centre for Development in Education (CDE), 2008; Milner & Khoza, 2008). Both the Third International Mathematics and Science Study (TIMSS) HSRC (2012) and World Economic Forum (WEF) (2011) annual reports echo the same sentiments: that South Africa's matriculants perform poorly compared with those of other developing nations like Colombia, Kenya, Malawi, Mauritius, Senegal, Tanzania, Tunisia and Zambia. Several factors contribute to this problem: inter alia, the lack of human and infrastructural resources to motivate the learners. Studies conducted by Howie (2012), Naidoo (2004) and Reddy, Kanjee, Diedericks and Winnaar (2006) confirm poor performance in Mathematics and Science subjects. Howie (2012) and CDE (2008) note that poor performance in Physical Sciences and Mathematics at secondary-school level is causing too few engineers and doctors to be graduating from universities and colleges.

Recently there have been initiatives by government, the private sector and civic groups aimed at positively influencing Physical Sciences performance. These include the initiative by the Department of Arts, Culture, Science and Technology (DACST) (1999), which launched the National Strategy for Mathematics, Science and Technology Education (NSMSTE) in 2001. The DACST initiative aimed at doubling

the number of learners who excel in Physical Sciences and Mathematics. Secondly, there is a study on improving science education conducted by the National Research Foundation (NRF) and the universities of Cape Town, Fort Hare and Venda (Baya'a & Daher, 2009). Thirdly, the Diploma in Education was recently upgraded to Advanced Certificate in Education (ACE), so that Science educators are equipped with better teaching skills and new Science pedagogy (DoE, 2010). Fourthly, the Department of Education (DoE) has established centres for Mathematics, Science and Technology in all provinces to support learning (DoE, 2010). Fifthly, the Electricity Supply Commission (Eskom) is providing scholarships and bursaries to both Science educators and Science learners to help further their studies in Science (Eskom Development Foundation Report, 2011). Sixthly, several local and international Information, Communication and Technology (ICT) companies have teamed up with the Department of Basic Education to launch the Vodacom Mobile education programme (Vodamobile, 2011) to boost Science learning in schools. Finally, the government has selected the best-performing high schools (now called Dinaledi high schools) countrywide and endowed them with extra human and material resources to enhance the performance of learners in Science and Mathematics (DoE, 2010). In addition to the above initiatives, the New Media Consortium and the EDUCAUSE Learning Initiative (2008), Goh and Kinshuk (2006) and Kenning (2007) observe that the use of cell phones in teaching and learning has gained ground in schools. Many schools the world over are now using cell phones in teaching and learning (Humble-Thaden, 2012; Vanska & Robertson, 2011).

Frاند (2000), DuVall, Powell, Hodge and Ellis (2007) and Hartnell-Young and Heym (2008) state that learners always get connected via short-message services, chat rooms and emails regardless of location. Furthermore, Everything Science and Platinum Science textbooks have been made available for use through the internet, for Grades 10, 11 and 12 (Shuttleworth & volunteers, 2011; Grayson, Harris, McKenzie & Schreuder, 2014). Ally (2009) and Brown (2005) state that learners of today have an information technology mind-set which is adapted to continuous multitasking.

Prensky (2001) describes today's learners as 'digital natives' because they are computer-literate and enjoy a life of using computers. In addition, Dede (2005) and Montgomery (2009) report that learners today have developed a 'neo-millennium

learning style' which confines them to internet use. In light of this, the use of cell phones in education becomes inevitable and helps to harness the interest of learners and possibly raise Physical Sciences pass rates.

Hennessy, Wishart, Whitelock, Deane, la Velle, Hitchcock and Hughes (1989), McFarlane, Ruthven and Winterbottom (2007) and McMahon and Pospisil (2005) propose a new pedagogy of teaching to meet the needs of today's learners, who are characterized by information-connectedness, with a focus on immediacy. Learners today concentrate on social intercourse and connectedness with friends, and enjoy group-based approaches to studying (Horrigan, 2008; Hahn, 2008; Aderinoye, Ojokheta & Olojede, 2007; Kim, Kim, Mims & Holmes, 2006). Thus the use of cell phones captures their interest and self-empowers learners (Humble-Thaden, 2012; Hennessy *et al.*, 1989; Bryan, 2004).

Even though the use of cell phones generates self-motivation, Oblinger and Oblinger (2005) and Wang, Shen, Novak and Pan (2009) believe that learners require only a moderate amount of information technology in the classroom. Notwithstanding their addiction to cell phones, learners still require the guidance of educators in their learning. They need face-to-face interaction with educators for a meaningful and effective transfer of knowledge (Wang *et al.*, 2009; Wang & Shih, 2008). This study explores the perceptions and attitudes of learners regarding the use of cell phones with internet services as instructional tools both on their own and with the guidance of educators.

1.3 JUSTIFICATION OF THE STUDY

As mentioned above, this study examines learners' and educators' perceptions of the use of cell phones as instructional instruments for Physical Sciences with a specific focus on Moretele high schools of the Bojanala district. A few related studies have been conducted involving the use of mobile learning devices, for example by Milrad and Spikol (2007) in Sweden, Baya'a and Daher (2009) in Jordan, and Aderinoye *et al.*, (2007) in Nigeria. However, this study seeks to contribute to the existing and growing body of knowledge on mobile learning by putting a specific focus on cell phones as instructional tools in the context of the provision of Physical Sciences

education in a rural community. There are a few reasons for conducting the study in high schools in the Moretele area.

Moretele is a rural community where the use of cell phones as instructional tools might be unfamiliar to both educators and learners. The participants are assumed to have had limited or no prior exposure to mobile technology, especially as an instructional tool in their education. Physical Science is generally regarded as a difficult subject by communal learners (Howie, 2012; Baya'a & Daher, 2009). Such an attitude prevails because high schools in rural settings have inadequate human and infrastructural resources. The study will raise awareness of the benefits to learners and educators of using cell phones in Physical Sciences teaching and learning.

Furthermore, the study will reveal learners' and educators' beliefs and attitudes about and towards cell-phone use in the teaching and learning of Physical Sciences. Cell-phone learning involves countless barriers that include culture, ignorance, economics and fear of opening up new opportunities for student learning (Harwood & Asal, 2007). This study seeks to establish whether the use of cell phones can arouse learners' interest in Physical Sciences and change their attitudes towards pursuing science career paths.

BuddeComm (2012) records almost 100% cell-phone penetration in South Africa. This has opened the way to the adoption of mobile technologies in teaching and learning (Vanska & Robertson, 2011). In 2009, the DoE took advantage of the phenomenal use of cell phones and made a public call to introduce mobile learning involving cell phones with internet services at pre-matriculation level and specifically in Grade 10 (Vanska & Robertson, 2011). This was an attempt to improve the weak national Grade 12 pass rates in Physical Sciences and Mathematics.

In spite of this unparalleled cell-phone penetration in South Africa, Traxler (2010) records that few people have hitherto extended the use of cell-phone technology to the teaching and learning environment. This clearly raises the question of what perceptions educators and learners have about the use of cell phones with internet services as an effective teaching and learning technology. Accordingly, this study seeks to measure participants' perceptions of the technology in four dimensions:

availability, accessibility, usability and methodology (Traxler, 2010; Hartnell-Young & Heym, 2008; Kim *et al.*, 2006).

At the beginning of 2012 the Minister of Basic Education, Angie Motshega, acknowledged that learners' performance in Physical Sciences and Mathematics in South Africa was a cause for concern (Politics web, 2012). In her announcement the Minister explained that in the 2011 National Senior Certificate examinations, while the pass rate for Physical Sciences had risen from 47.8% to 53.4%, that of Mathematics had declined from 47.4% to 46.3%, and the two subjects were still well below the national benchmark of 70%. An analysis of Table 1 below shows a pass rate averaging 60.9% over a five-year period. This makes it necessary to develop new techniques of teaching Physical Sciences. One of the suggestions on the table is to integrate cell-phone learning into the teaching of Physical Sciences.

Table 1.1: National Physical Sciences key indicators (2011-2014)

Year	Start of grade 12 total enrolment	Science enrolment	% of matric enrolment for science	End of grade 12 total exam takers	Science exam takers	% of exam takers writing science exams	Achieved at 30% and above	% at 30% and above
2011	534.498	184.052	34%	496.090	180.585	36.4%	96.44	53.4%
2012	551.837	182.126	33%	511.152	179.194	35.1%	109.918	61.3%
2013	576.490	187.109	32%	562.112	184.383	32.8%	124.206	67.4%
2014	550.127	171.549	31%	532.860	167.997	31.5%	103.348	61.5%
Averages	553.238	181.209	32.5%	525.554	178.04	33.95%	108.478	60.9%

www.equaleducation.org.za (Louw, 2015).

The ICT Update (2011) records that Science and Mathematics drop-out rates remain unacceptably high, with about 218 156 Physical Sciences candidates in 2008, 225 148 in 2009, 205 364 in 2010, and 180 585 in 2011, a fall of 17.2% in four years. The realities stated above provide the rationale for undertaking a study that investigates educators' and learners' perceptions of cell phones as effective and cost-effective instructional tools for Physical Sciences teaching and learning in South Africa.

Finally, even though there has been a public call to integrate teaching and learning with cell phones, it is evident that the results have not changed yet. In fact, the use of cell phones with internet services as instructional tools in some countries is receiving criticism from other researchers, for example Wang *et al.*, (2009), Wang and Shih (2008), Kukulska-Hulme (2007), Cobcraft, Towers, Smith and Bruns (2006) and Goh and Kinshuk (2006). Therefore, collecting the views and opinions of educators and learners on the perceived impact of the use of cell phones in transferring knowledge may shed more light on the integration of related technologies into the classroom.

1.4 STATEMENT OF THE PROBLEM

The study examined the perceptions of Grade 10, 11, and 12 Physical Sciences learners and their teachers regarding the use of cell phones with internet services in the teaching and learning of Physical Sciences.

The poor performance of learners in Physical Sciences is cause for concern. Various factors such as material resources, teachers' mastery of the subject and the pedagogical strategies used have been widely reported (Milner & Khoza, 2008). Little has been done in South Africa to explore the possibilities of using cell phones with internet services as a resource which can assist in the teaching of Physical Sciences.

Yet the South African education system is faced with the challenge of raising pass rates in Physical Sciences (Taylor, 2008; Milner & Khoza, 2008; DoE, 2010; Politics web, 2012). South Africa ranks almost at the bottom of the list of African countries (DBE, 2013; WEF annual report, 2011). Table 1.2 below shows how South Africa's

Grade 9 learners compare in Mathematics and Science with their peers in Botswana and the Central American country Honduras.

Table 1.2: Grade 9 learners' average performance in Mathematics and Science

Country	Mathematics		Science	
	Average	SE	Average	SE
Botswana	397	2.5	404	3.6
South Africa	352	2.5	332	3.7
Honduras	338	3.7	369	4

Highlights from TIMSS (2011): The South African Perspectives. HRC (2012)

Out of the three countries, the South African learners scored the lowest in Science. Public and private sectors, as discussed in sections 1.2 and 1.3, have initiated a number of strategies. In 2008 the DoE embarked on a massive recruitment of foreign specialist educators to deal with the national problem. At the same time, the phenomenal growth in cell-phone use provided a vital opportunity for integrating the device into the teaching and learning of Physical Sciences because of the benefits stated in section 1.2.

Studies by Williams (2009), Johnson and Kritsonis (2007) and Kolb (2008) have paid attention to the acceptance, adoption and rejection of cell phones as instructional tools. This study centres on perceptions of the use of cell phones with internet services in rural community-based schools, taking cognizance of the fact that cell phones are being used as instructional tools in education.

1.5 THE RESEARCH QUESTION

In view of the problem stated above, the research question is thus stated as follows:

What are learners' and educators' perceptions of the use of cell phones as instructional tools for Physical Sciences in Moretele high schools of the Bojanala district?

1.5.1 Research sub-questions

In order to address the question in 1.5 above, learners' and educators' perceptions are revealed through the following sub-questions:

- ❖ What benefits do learners perceive in the use of cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ What benefits do educators perceive in the use of cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ What drawbacks do learners perceive in the use of cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ What drawbacks do educators perceive in the use of cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ Do learners want to continue using cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ Do educators want to continue using cell phones with internet services in the teaching and learning of Physical Sciences?

1.6 AIM OF THE RESEARCH

This study seeks to examine educators' and learners' perceptions of the use of cell phones with internet services in the teaching and learning of Physical Sciences in Moretele high schools of the Bojanala district. The study is conducted from the end-users' perspective involving educators and learners in Moretele high schools of the Bojanala district in the North West (NW) province of South Africa. Prior studies of this particular kind of technology have tended to focus on the factors for its adoption or rejection. The aim of this study is to focus specifically on the views of key stakeholders who are also end-users as to the perceived use of mobile-phone technology in the teaching and learning of Physical Sciences.

Accordingly, this study seeks to suggest and recommend solutions to help fully utilize cell phones with internet services in the teaching and learning of Physical Sciences with the objective of improving performance and results. It is hoped that the results of

this study will provide important insights as to the applicability of cell-phone technology in the teaching and learning of Physical Sciences.

1.7 ASSUMPTIONS

- ❖ Selected high schools use cell phones with internet services in the delivery of Physical Sciences education.
- ❖ Educators and learners have comments to make about cell phones with internet services in learning and teaching.
- ❖ Educators and learners are going to co-operate in providing sincere responses to both the questionnaires and the interviewers.
- ❖ Time and resources will be available to complete the research in time.

1.8 DEFINITIONS OF KEY TERMS

The following key terms are explained below to clarify their usage.

- ❖ **Educator** denotes a teacher or a person who facilitates the acquisition of knowledge and skills by learners in a public school.
- ❖ **Learner** denotes a pupil or student who is guided and assisted by the educator to acquire knowledge and skills through formal learning at school.
- ❖ **Perceptions** are views, beliefs, attitudes or understanding derived from the use of cell phones in the teaching and learning of Physical Sciences.
- ❖ **Educators' perceptions** are the views, beliefs and attitudes which an educator holds regarding cell-phone use in the teaching and learning of Physical Sciences.
- ❖ **Learners' perceptions** are the views, beliefs and attitudes which a learner holds regarding cell-phone use in the teaching and learning of Physical Sciences.

1.9 CHAPTER SUMMARY AND STRUCTURE OF THE DISSERTATION

The study is structured as follows.

Chapter 1: Introduction and Purpose of the Study. This chapter focuses on the context within which the research was conducted and the background to the research. It contains a brief outline of the background, the problem, the aims of the research, the research question and sub-questions, justification of the study, assumptions, definitions of terms and the structure of the study.

Chapter 2: Review of Related Literature. This chapter surveys the views of various authorities on mobile learning and e-learning with specific reference to the use of cell phones, and gives the theoretical framework which underpins the study.

Chapter 3: Research Methodology. This chapter provides a detailed discussion of the data-collection procedures, tools and techniques used in the study. It provides the rationale for their selection and subsequent use in the study.

Chapter 4: Data Presentation and Analysis. This chapter presents the results and analyses them in the form of figures, graphs and tables.

Chapter 5: Summary, Conclusions and Recommendations. This chapter looks at the findings and discusses them with reference to theory and empirical evidence. The researcher also offers reflections on the whole document as to its applicability and feasibility. The conclusions drawn from the study are stated and recommendations are made, based on its findings.

Finally, this chapter lays the foundation of the study, stating the background, justification of the study, the research problem, the research question and sub-questions, research design and methodology, assumptions, and definitions of key terms. After this foundation, the study next surveys the literature related to mobile learning and specifically the use of cell phones in the teaching of Physical Sciences.

CHAPTER 2

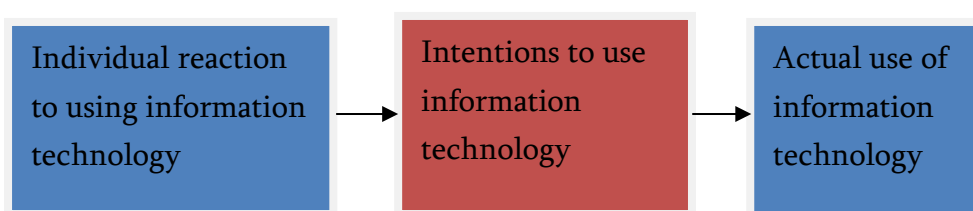
REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

This chapter discusses the related literature on the perceptions of learners and educators regarding cell-phone use in the teaching and learning of Physical Sciences. The following theories on the adoption of technology will be explored: the Technology Acceptance Model (TAM) by Davis (1989) and the Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1975). Learners' and educators' perceptions of the use of mobile technology, reactions to mobile technology, intentions to use it and understanding of benefits derived from its actual use will be looked at in this chapter.

2.2.1 Theory on adoption of technology and mobile services

Sheppard, Hartwick and Warshaw (1988) state that the intention to use information technology is a valid predictor of behavior such as the adoption and use of technology. It is therefore necessary to have a look at the adoption theories in order to explain more about the perceptions and intention to use cell phones with internet services by learners and educators. Venkatesh, Morris, Davis and Davis (2003) state that user acceptance of information technology such as mobile phones in Physical Sciences learning employs (a) intention to use and (b) actual use as the main dependent variables. The following figure 2.1 shows the basic concept:



**Figure 2.1: Theoretical model on user acceptance of information technology
(Sendecka, 2006)**

In the above flow diagram, the individual's initial reaction influences his or her intentions of using the new technology. This will determine the actual use of the technology in the end. Therefore, educators' and learners' perceptions of cell-phone usage in Physical Sciences learning depend on their initial individual reactions and views. The individual perceptions will then lead to the intention to use the technology and this intention stimulates actual use. Initially, mobile phones with internet services need to be received positively in education before intentions of usage are formed and actual use is undertaken. The theory of reasoned action (TRA) relates directly to perceptions of the adoption of mobile learning in education.

2.2.2 The theory of reasoned action (TRA)

The TRA is one of the most influential theories of a wide range of human behaviour (Venkatesh *et al.*, 2003). It suggests that attitudes towards behaviour and subjective norms will determine intention to perform behaviour. The TRA asserts that the behavioural intention, rather than attitudes alone, determines actual behaviour in cell-phone teaching and learning (Kassarjian & Robertson, 1991). The TRA is centred on the relationship between attitudes and behaviour (Fishbein & Ajzen, 1975).

In this study the perceptions and attitudes of both teacher and learner are pivotal in the adoption and usage of cell phones with internet services in teaching and learning. The TRA tries to predict behaviour in situations where the learner and teacher control their own behaviour and are thoughtful about it. It states that the most important determinant of learners' and teachers' actual behaviour is the intention to behave, which is predetermined by attitudes (Fishbein & Ajzen, 1975). Educators and learners in high schools need to be positively inclined in order for cell-phone teaching and learning to be successful. The following TRA diagram gives an overview (see figure 2.2).

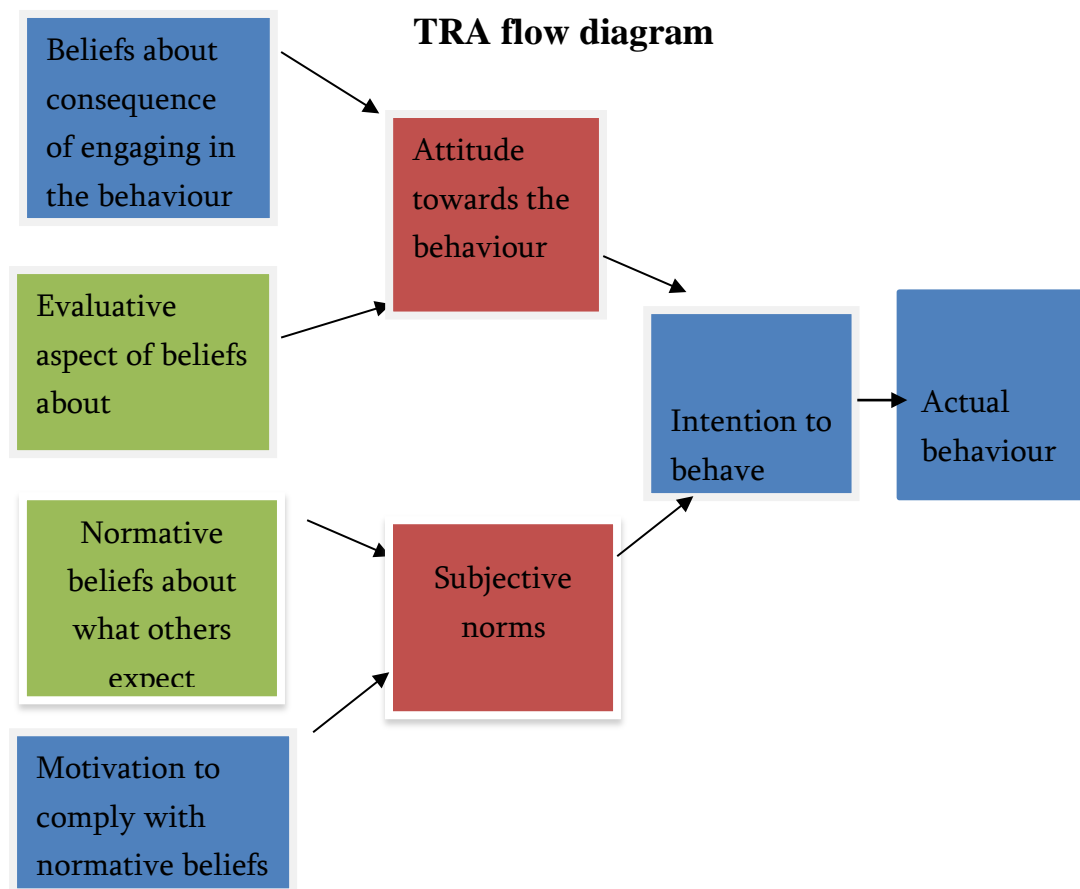


Figure 2.2: Theory of reasoned action (Kassarjian & Robertson, 1991)

Figure 2.2 illustrates the fact that intention to behave is a direct determinant of actual behaviour and intention to behave arises from attitude toward the behaviour and subjective norms (Kassarjian & Robertson, 1991). If the attitudes and behaviour of educators and learners are positive towards cell-phone use in teaching Physical Sciences, then adoption of the technology is going to be successful. The TRA assists in linking the behaviour of educators and learners to their intentions and use of cell phones. In the TRA the attitudes towards adopting cell phones with internet services in teaching and learning determine beliefs and the evaluative aspects of beliefs on the adoption of the technology (Fishbein & Ajzen, 1975). On the other hand, subjective norms influence normative beliefs about what others expect and the motivation to comply with normative beliefs (Kassarjian & Robertson, 1991). The TRA informs us that Learners and educators have perceived pressure to engage or not to engage in cell-phone use in the teaching and learning of Physical Sciences. Also the perceived

pressure may come from peers, teachers, parents and/or social media (Fishbein & Ajzen, 1975).

Fishbein and Ajzen (1975) explain attitudes as an individual's positive or negative feelings concerning a desired behaviour. This means that, in order to predict a specific behaviour of a learner, it is necessary to measure the individual's attitudes toward performing that behaviour (Kassarjian & Robertson, 1991). Fishbein and Ajzen (1975) further state that subjective norms refer to the individual's perception of what important people expect of him or her.

In other words, subjective norms as from the TRA tend to explain the social influences and perceptions that a learner's behaviour is exposed to. Kassarjian and Robertson (1991) suggest frequent use as influential in the adoption of technology. For example, the use of mobile phones with internet services by people of different ages and sexes and the influences of peers and educators may cause learners to like or dislike cell phones as tools for learning and teaching purposes. The TRA explains that normative beliefs are guided by others' expectations of what the person should or should not do (Fishbein & Ajzen, 1975). Besides, performance of a particular behaviour is influenced by others' opinions about that behaviour. Other people can encourage or discourage an individual to do or refrain from doing a deed.

The findings of Fishbein and Ajzen (1975) also suggest that in high-school settings, intentions to use mobile technology depend not only on personal attitudes towards the technology but also on the influence of the opinions and perceptions of others, especially educators, parents, peers and the social media. BuddeComm (2012) and Prensky (2010) report on the overwhelming use of cell phones with internet services by young people of school going age, which indicates that there is positive influence from their environment.

Venkatesh and Davis (2000) state that individuals have a tendency to conform to behaviour outside their wish through influence from people they see as important. On this view, the introduction of cell-phone learning and teaching can be undertaken because cell phones are in wide usage and studies by some academic authorities such as Masero (2008) and Roschelle, Patton and Tatar (2007) support this move.

The TRA links motivation to comply as a person's motivation to conform to normative beliefs (Harrison, Mykytyn & Riemenschneider, 1997). The beliefs that other referents such as parents and educators have towards cell-phone use in high school affect such use either positively or negatively (Fishbein & Ajzen, 1975). Learners unavoidably use cell phones in general everyday life since the world is now computer-inclined (Wang *et al.*, 2009).

All in all, the TRA suggests that the behaviour of learners, parents, educators and peers is central to the success of the mobile teaching and learning of Physical Sciences. The behaviour of learners, educators, peers and parents will depend on their motivation, attitudes and beliefs. Positive behaviour will lead to continued usage while negative behaviour will reduce cell-phone usage in teaching and learning in schools (Kassarjian & Robertson, 1991; Fishbein & Ajzen, 1975).

The next section deals with the Technology Acceptance Model (TAM) as also relevant to this study.

2.2.3 The technology acceptance model (TAM)

The TAM model applies widely to user acceptance and usage (Ma & Liu, 2004). According to Venkatesh and Davis (2000), the TAM is a powerful tool for predicting user acceptance of mobile technology. In teaching and learning using cell phones, the TAM fits in very well as it gives a vivid explanation of perceptions influencing adoption.

The TAM proposes several antecedents to attitude towards use, which are: perceived expressiveness, perceived enjoyment, perceived usefulness, perceived ease of use, and normative pressure (Ma & Liu, 2004). These factors as stated in the TAM directly influence learners' and educators' use of mobile technology. According to Fishbein and Ajzen (1975), the TAM propounds that the intention to use a system depends on variables such as its perceived usefulness and perceived ease of use. The flow diagram figure 2.3 illustrates the variables.

Flow diagram: Technology acceptance model

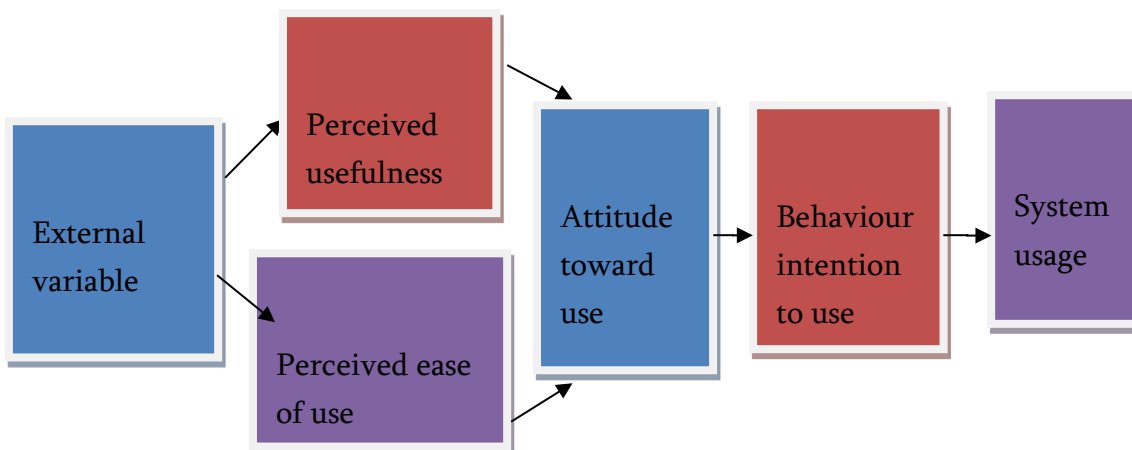


Figure 2.3: Technology acceptance model (Mac & Liu, 2004)

Venkatesh and Davis (2000) contend that perceived usefulness and ease of use disturb external variables, such as development process, training and intention to use a system. Venkatesh and Davis (2000) seem to assert that perceived usefulness and ease of use form the basis of learners' and educators' beliefs about mobile technology. These variables in turn form the bases of learners' and educators' attitudes towards mobile technology that will predict intention to use cell phones with internet services in the learning and teaching of Physical Sciences.

As in the TAM Davis (1989) explains perceived usefulness as the extent to which a person believes a particular technology will help him or her to improve his or her work. According to the TAM Learners and educators will accept the use of mobile phones with internet services in the learning and teaching of Physical Sciences because of its ease of use and the hope it gives of improving performance in the subject (Venkatesh & Davis, 2000).

Cassidy, Park, Butovsky and Braungart (1992) argue that perceived expressiveness is the ability of an individual to express his or her emotions. In cell-phone learning and teaching, learners and educators alike are able to explore and express Physical Sciences ideas in an environment conducive to their needs and privacy. Davis, Bagozzi and Warshaw (1992) explain perceived enjoyment as the degree to which an individual perceives mobile technology to be pleasurable apart from any other values that may be expected. Nowadays learners use mobile phones with internet services in

the learning of Physical Sciences because they believe that this technology is quick in responding and easy to use and adds value to their learning (Prensky, 2010; Kenning, 2007).

Davis (1989) adds that perceived ease of use is the persuasion which a person holds upon using a particular technology, such as that it is simple and free of effort. The TAM links the rationale behind the relationships between technology and use. It suggests that if technology is easy to use, and is found to be particularly useful, it will have a positive influence on the intended user's attitude and its usage will increase (Taylor & Todd, 1995; Cassidy *et al.*, 1992). The frequent use of cell phones with internet services by learners today tells us that it is easy, interesting and convenient to them (Bureau of Marketing Research (BMR), 2012; Prensky, 2010). Therefore using it in the delivery of Physical Sciences might be appropriate and add value to their learning.

In conclusion, the two adoption theories, namely the theory of reasoned action (TRA) and the technology acceptance model (TAM), form the theoretical framework for this study. They guide this study on what influences the perceptions of educators and learners towards the eventual adoption of cell phones with internet services in the teaching and learning of Physical Sciences.

In the next section, a discussion will be undertaken with a special focus on empirical evidence.

2.3 EMPIRICAL EVIDENCE

Under empirical evidence, the following aspects are discussed:

- ❖ learners' perceptions of cell phones with internet services in teaching and learning;
- ❖ educators' perceptions of cell phones with internet services in teaching and learning;
- ❖ the use of cell phones with internet services in teaching and learning;
- ❖ the delivery of Physical Sciences lessons in high schools;

- ❖ the impact of cell phones with internet services in learning;
- ❖ attributes of mobile phones with internet services in the learning and teaching of Physical Sciences;
- ❖ limitations of mobile phones with internet services in the learning and teaching of Physical Sciences; and
- ❖ mobile learning and electronic learning.

2.3.1 Learners' perceptions of cell phones in teaching and learning

Johnson (2013), Johnson and Kritsonis (2007) and Obringer and Coffey (2007) observe that children place a greater value on the technological capabilities of the cell phone with internet services and its potential to facilitate socialization. The TAM, explained in section 2.2.3 above, supports as influential in the adoption of a technology its technological capabilities and its use in socialization. A study by Thornton and Houser (2005) of university students in Japan revealed that more than three quarters of the students who received emails on their mobile phones learnt more than those receiving identical materials on paper did. A longitudinal study carried out for eight years at Brewster Academy in New Hampshire, cited by Bain and Ross (2000), showed that learners who had technology integrated into their instructions scored a combined 94 points better on the same test than learners who had no technology instructions in their test.

From the findings of Thornton and Houser (2005) and Bain and Ross (2000), we notice that learners have positive motives and understand better when they use technology in an instructional mode. The TRA and TAM (sections 2.2.2 and 2.2.3) highlighted attitude, motivation and perceived ease of use as essential elements towards the adoption of technology (Kassarjian & Robertson, 1991; Fishbein & Ajzen, 1975). Learners of today like cell phones; they have a positive attitude and behaviour towards their use (Dede 2005; Hahn, 2008).

Furthermore, studies by Matt Cook (cited in Kollie, 2011) and Kihwele (2012) indicate that learners' engagement, excitement and confidence are elevated when they use cell phones with internet services. The New Media Consortium and the EDUCAUSE Learning Initiative (2008) acknowledged the use of mobile phones with

internet services as educational tools becoming more widespread among and accepted by learners. The BMR's 2012 study on Gauteng secondary learners revealed that about 73.8% of them knew a cell phone with internet services as a learning tool. Similarly a survey by Project Tomorrow (2010) revealed that 60% of the learners from Grade 6 to 12 thought that using their own cell phone with internet services improved learning and 62% of the parents were prepared to buy them for their children. Fishbein's and Ajzen's 1975 findings on the TAM suggest motivation from within and without, perceived usefulness and perceived ease of use as central to the use of cell phones by learners and educators.

Today many learners make use of mobile phones with internet services in their learning because they are intrinsically motivated (BMR, 2012; Project Tomorrow, 2010). The use of cell phones in teaching and learning should be considered seriously since it caters for the learning needs of learners anywhere they go irrespective of time (O'Malley, Vavoula, Glew, Taylor & Sharples, 2005; Thornton & Houser, 2005; Prensky, 2013).

A survey carried out by Manzo (2009) revealed that 89% of learners were positively engaged by the use of technology in the learning environment, while 96% of students demonstrated improved learning performance and achievement when technology was integrated into their curriculum. This is supported by the TAM and TRA, which attribute positive behaviour to positive beliefs and attitudes (Kassarjian & Robertson, 1991; Fishbein & Ajzen, 1975). O'Malley *et al.*, (2005), study of learners' perceptions of online and distance learning revealed that learners perceive online learning to have significant advantages over traditional classroom-based learning. Studies by Masero (2008), Venkatesh, Nargundkar, Sayed and Shahaida (2006), Rogers, Connelly, Hazlewood & Tedesco (2010) and Pollara and Broussard (2011) show that cell phones with internet services improve understanding and learning experiences and make the learning process more interesting for students. Learners say that the study materials they get from cell phones make them more engaged with real-world issues and situations (Wang *et al.*, 2009; Rogers *et al.*, 2010; BMR, 2012). This is supported by Kassarjian and Robertson (1991) in the TRA (section 2.2.2) and by Fishbein and Ajzen (1975) in section 2.2.3, who argue that positive attitudes towards cell phones, and their usefulness, contribute to their adoption. Therefore,

educators and learners with positive behaviour towards the use of cell phones with internet services in Physical Sciences need to be encouraged and supported (Prensky, 2010; Pollara & Broussard, 2011).

Tapscott (2009) argued that wealthy people in America were information-rich while the poor people were information-poor. In view of this contention, schools must be information-rich, and are the best places to correct this digital divide (Harwood & Asal, 2007). Willoughby (2008) observed that learners spent more time on the internet as a result of their positive perceptions. Therefore it is necessary for cell phones with internet services to be integrated into teaching and learning in order to sustain our learners' interest in education (Roos, 2002; Rosenberg, 2001). \

However, Wagner (2008) cautioned that technology in itself might not necessarily guarantee better learning. Some teachers' pedagogical beliefs may stand in the way of full integration of cell-phone use into instruction (Ertmer & Ottenbreit-Leftwich, 2010). Therefore every step we take in implementing cell-phone use in education must be studied properly and implemented with caution so that we are able to get the full benefits.

2.3.2 Educators' perceptions of cell phones in teaching and learning

The views of educators and researchers will be of importance in guiding us as to the perceived views of the stakeholders on cell phones' use in teaching and learning. Some educators regard the use of cell phones by learners at school as a deterrent to learning while others regard it as a tool for effective learning (Johnson & Christonis, 2007). Prensky (2013) contends that today's learners are digital natives with the motivation to learn differently compared with learners of the 20th century. Researchers such as Barker, Krull and Mallinson (2005) and Swarts and Wachira (2010) agree that mobile learning is a vehicle to cross the digital divide. Learners and educators need to be positively inclined in order to use cell phones with internet services fruitfully. Internet world stats (2011) and I.T.U (2012) posit that mobile devices will in future narrow the existing digital divide experienced in developing countries. Roberts and Butcher (2011) contend that cell phones bring education even

to the most remote communities. Aker (2008) notes that cell phones are more accessible to rural communities in cost, geographic coverage and ease of use.

From the above observations by Barker *et al.*, (2005), Roberts and Butcher (2011), Internet world stats (2011) and I.T.U (2012), it seems that cell phones are vital tools in education. If cell phones are perceived positively by learners, as explained in TAM section 2.2.3, they can help to bridge the gap between the rich and the poor (Vodamobile, 2011; Attewell, 2005). Attewell (2005) adds that mobile learning addresses the social educational problems of youths between 16 and 24 years of age such as poor literacy and/or numeracy and non-participation in conventional education through lack of access.

According to Prensky (2010), many teachers worldwide now use cell phones as a learning tool. Nokia Conversations (2012) contends that mobile technology shifts learning into the learner's personal life and environment, embracing both the physical and the spiritual aspects of life and allowing learning to become more collaborative and lifelong. This is in line with the TRA and TAM, explained in sections 2.2.2 and 2.2.3, which emphasize positive beliefs and attitudes as pivotal to the use of cell phones with internet services (Kassarjian & Robertson, 1991; Fishbein & Ajzen, 1975). In view of the above perspectives, it can be noticed that the use of mobile phones with internet services might actively stimulate and assist learners to learn not only Physical Sciences but also other subjects, irrespective of their social and economic background.

Furthermore, studies carried out in Sweden by Milrad and Spikol (2007), in Jordan by Baya'a and Dayer (2009), in Nigeria by Aderinoye *et al.*, (2007), in Japan by Thornton and Houser (2005) and in the United Kingdom by Bain and Ross (2000) have shown that mobile learning helps to reduce the problems of literacy and numeracy in young people. Holzinger, Nischelwitz and Meisenberger (2005) and Al-Fahad (2009) point out that mobile learning is an important instrument for lifelong learning, while Carmichael, Fox, McCormick, Procter and Honour (2006) assert that mobile learning is now a necessity, not an option.

According to Nokia Conversations (2012), chat applications of cell phones with internet services can lead to real-time discussions between educators and learners, or among learners, in web forums. The TRA and TAM, discussed in sections 2.2.2 and 2.2.3, support positive behaviour on the use of a technology (Kassarjian & Robertson, 1991; Fishbein & Ajzen, 1975). In addition, educators' marking load is reduced, and they can have more time to help learners individually and to give them instant feedback at critical times (Vanska & Robertson, 2011; Alexander, 2004). The sentiments expressed by Vanska and Robertson (2011) and Alexander (2004) reflect that the perceived usefulness of cell phones with internet services is central to their being used. This is also explained in the TAM by Fishbein and Ajzen (1975). Kenning (2007), Habitzel, Mark, Stehno and Prock (2006), Quinn (2000) and Mellow (2005) state that mobile phones with internet services can be used to introduce small lessons that are easier to remember and more compatible with the hectic lifestyles of some learners.

From the above observation by Kenning (2007), Habitzel *et al.*, (2006), Quinn (2000) and Mellow (2005), it can be observed that cell phones with internet services can fit into the lifestyles of learners. To sum up, Masero (2008) and Roschelle, Patton and Tatar (2007) assert that mobile devices with internet services make Physical Sciences lessons (a) student-centred, (b) assessment-centred, (c) knowledge-centred and (d) community-centred.

Additionally, Silander, Sutinen and Tarhio (2004) maintain that mobile devices extend the learning environment in which the learners work and integrate it with real-life situations. According to Quitadamo and Brown (2001) and Ting (2007), mobile learning guides a learner to an authentic learning context by incorporating the subject-relevant objects with closely related information in the handheld device to facilitate the process of acquiring knowledge. Quitadamo and Brown (2001) argue further that authentic situations and scenarios stimulate student learning, as well as creating greater motivation and excitement for it. In view of the above, it can be seen that mobile technology is a motivational tool that stimulates and creates greater opportunities for excitement for today's learners to learn even Physical Sciences. Quitadamo and Brown (2001) concur with the TRA (section 2.2.2) and TAM (explained in section 2.2.3), which emphasize that positive motivation leads to

positive behaviour. In this case learners of today are positively motivated towards the use of cell phones with internet services and as a result use them frequently.

Dewitt and Siraj (2010), Daher (2009) and Scardamalia and Bereiter (2006) contend that the classroom needs to nurture change, on the part of learners and educators, in seeking the best way to replace classroom-bred discourse with modern ways. In this regard, we see the cell phone with internet services as best fitting this scenario. It provides a paradigm shift from the traditional means of teaching and learning using paper and chalk to paperless teaching. Cell-phone teaching and learning are learner-centred as they focus on the immediate and contextualize situations to match the modern context (Kenning, 2007; Prensky, 2010; Chen, Chang, Shen, Wang, Chang & Shih, 2010). Duffy and Cunningham (1996) note that mobile technology facilitates learning by providing simulation of real-life contexts through giving simple illustrations to enable learners to solve complex problems.

Researchers such as Harwood and Asal (2007), Montgomery (2009) and Palfrey and Gasser (2008) state that cell-phone abuse by learners, teachers' attitudes, ignorance, accessibility, professional development and school safety are major barriers in implementing mobile technologies in schools. This agrees with the TRA (section 2.2.2) and TAM (section 2.2.3), which highlight negative perceptions as hindrances to learners' and educators' use of mobile technology.

Marshall (2008) has listed the ways in which Information and Communication Technologies affect pedagogical practice and student learning as (a) forming government policies, (b) directing teacher education programmes, (c) advancing national curricula, (d) designing or reforming classroom implementation and (e) analysing costs and benefits.

In view of Marshall's (2008) assertion we see mobile technology as having a great impact on pedagogical practice and student learning. Integration of mobile technology coupled with well-planned and supportive implementation can facilitate positive changes in education (Hobbs & Christianson, 1997).

In general, researchers and educators agree that learners use mobile phones frequently and have positive behaviour and attitudes towards their use. This is supported by the TRA and TAM, which propound that positive behaviour and attitudes lead to positive use of cell phones (see sections 2.2.2 and 2.2.3 respectively).

2.3.3 Use of cell phones in teaching and learning

In spite of the ubiquity of mobile phones with internet services among learners, the use of these devices in education is still new and in its infancy (Chen & Kinshuk, 2005; Rismark, Sølvsberg, Strømme & Hokstad, 2007). I think that using this ubiquitous technology will create a wide range of educational benefits and opportunities. Moreover, the commonness of mobile phones with internet services amongst learners in high school gives us a clear opportunity to utilize them in Physical Sciences teaching and learning (BMR, 2012; Cobcraft *et al.*, 2006).

Van Biljon (2006), Prensky (2013) and UNESCO (2012) describe mobile technology communication as a new way to take in order to educate today's learners. Mobile technology provides mobile internet contact that is accessible, rich in content, efficient, flexible, secure, reliable and interactive (Wang, Chen & Fang, 2011). In addition, m-learning appears to offer possible solutions for the shortcomings of the traditional classroom-based practices, which are teacher-centred (Shuler, 2009; Traxler, 2010).

Vanska and Robertson (2011) say that mobile learning connects formal learning experiences in classrooms with informal learning experiences. Cell phones with internet services can be used to search for information, interact with educators and other learners, and access course materials anywhere and at any time (Shuler, 2009). Cell phones with internet services support the execution of tasks which are closer to the learners' experiences. This is in line with perceived usefulness as explained in TAM section 2.2.3.

Shuler (2009) and Young (2011) add that lifelong learners need effective tools to record, organize and reflect on their mobile learning experiences. The South Africa-Finland Partnership (SAFIPA) (2012) argues that the mobile learning programme has

an easy interface for both learners and educators. It allows learners to understand and develop their competencies while educators on the other hand can easily send ad-hoc tests to pupils, tap into a practically endless exercise bank and gain an understanding of their learners' competency levels and improvement areas. This concurs with the TRA and TAM, as explained in sections 2.2.2 and 2.2.3 respectively, on perceived usefulness as pivotal to the continued use of cell phones. Learners can proactively excel in Physical Sciences through exercises and tests, and are encouraged to compete with other learners on the test score and mobile rankings, while educators can immediately view where their class's weak points lie and then proactively strategize to assist them in class tuition and by encouraging the learners to do more mobile Physical Sciences (SAFIPA, 2012). In the light of the above, cell phones with internet services, if properly integrated into the learning of Physical Sciences, will help to improve pass rates.

Botzer and Yerushalmy (2007) and Genossar, Botzer and Yerushalmy (2008) all agree that many learners own mobile phones and handheld devices with internet services. Eagle (2005) further states that mobile phones with internet services are more prevalent in poor communities in the African rural and remote areas than desktop computers are. In view of the commonness of cell phones with internet services, their use in the teaching and learning of Physical Sciences can be convenient and indispensable in schools. Therefore schools must not alienate learners from their real societies but must make them fit and be adaptive to the new technology (Prensky, 2013; Kihwele, 2012; Young, 2011).

2.3.4 Delivery of Physical Sciences lessons in high schools

Studies carried out by the DoE (2001), Reddy, Kanjee, Diedericks and Winnaar (2006), the Centre for Development in Education (CDE) (2008) and UNESCO/UNICEF (2005) have shown that South Africa's learners perform badly in Physical Sciences and Mathematics. Jarret (1998) and Selvaratnam (2011) have attributed poor performance in Physical Sciences and Mathematics to traditional teaching methods that are based on memorizing facts and formulae. Selvaratnam (2011) further states that the examinations place more emphasis on content knowledge than on intellectual abilities. All this suggests that the teaching and

learning of Physical Sciences in South Africa's high schools need to be revolutionized to facilitate the smooth progression of learners into tertiary institutions.

This could be done through the use of cell phones in teaching and learning. Jarret (1998) suggests that the use of ICT resources in the teaching and learning of Physical Sciences and Mathematics can help to improve the poor performance in these subjects. On a similar note, Stead, Sharpe, Anderson, Cych and Philpott (2006) argue that mobile learning can shift the focus from theorizing concepts to their practical application to real situations. Dewitt and Siraj (2010) add that ICT and online discussions enable learners to take part in processes of authentic collaboration and knowledge-building similar to those used by scientists, thus reflecting the nature of science. This can facilitate higher-order thinking in Physical Sciences.

The new South African school Curriculum and Assessment Policy Statement (CAPS) (DBE, 2011) for Physical Sciences advocates the development of intellectual skills and strategies in the teaching and learning of Physical Sciences through using cell phones with internet services (DBE, 2011). Books prepared for the CAPS syllabus by Shuttleworth and volunteers (2011) and Grayson *et al.*, (2014) have a clear emphasis on the use of cell phones with internet services in the learning and teaching of Physical Sciences. This is a new approach being introduced in South Africa to teach Physical Sciences. However, we still need to find out whether our learners and educators are ready to accept cell-phone learning. Rosenberg (2001) and Adam and Ham (1999) state that learners need to be actively involved in cell-phone use as individuals, with peers, or in groups.

On the other hand, Paul (1995) says that the introduction of mobile technology can create or destroy jobs, and it affects the ways in which we teach and learn. Cuban, Kirkpatrick and Peck (2001) add that mobile technology is changing quickly, difficult to control and unreliable. Paul (1995) also contends that while mobile technology can bring in positive changes to the education system, a lot of research needs to be done to find the best ways of integrating it into teaching and learning.

This investigation focuses on the readiness, perceptions and attitudes of educators and learners regarding the adoption of cell phones with internet services in the teaching

and learning of Physical Sciences in high schools. In this regard, the attitudes and perceptions of educators and learners regarding the use of mobile technology in teaching will help to gauge whether mobile technology is likely to benefit the Physical Sciences pass rate at Senior Certificate level.

2.3.5 Impact of cell phones on teaching and learning

Roberts and Butcher (2011) note that between 2008 and June 2009 there were 280 learners from six high schools who participated in the Nokia project for mathematics. This number grew to 4000 learners and 72 educators in 30 high schools in the following year, 2010. The results from the Nokia project S.A showed a 14% rise in mathematics competency. The above statistics suggest that cell-phones can be integrated into the teaching and learning of Physical Sciences. The BMR's (2012) research further supports the above notions with the following statistics: The BMR's (2012) research further supports the above notions with the following statistics:

- ❖ Approximately seven in every 10 learners (73.8%) have used cell phones as learning tools.
- ❖ Learners who have used cell phones as learning tools have accessed the internet via their cell phones to assist with mathematical (24.2%) and language (12.3%) assignments and to browse for information for schoolwork (23.0%) and general (21.6%) purposes.
- ❖ Approximately 10% of learners have stored content on their cell phones to use in an examination or test or used cell phones to receive information or answers in examinations or tests or to assist friends during examinations or tests.
- ❖ Approximately 80% of learners would like to receive reminders for school assignments or projects, have online tutors to assist with school assignments or projects, have an online blog to discuss school assignments or projects, and receive information about school events by cell phone.

In the light of BMR (2012), we see that learners use cell phones for various academic purposes although they sometimes misuse them for non-academic or anti-academic purposes. Therefore, the education system in South Africa needs to find suitable

strategies to incorporate cell phones formally into the teaching and learning process. Begley Jr, cited in Copeland (2011), points out that in education we should communicate with learners using the language of technology which they understand best.

The empirical evidence gathered shows that the direct recipients of mobile learning, educators and learners, have positive attitudes towards the use of cell phones with internet services in education (Sandholtz, Ringstaff & Dwyer, 1997; Perry, 2003; Netsu, 2006). Researches already done also reveal that learners and educators are actually involved in using cell phones with internet services as tools for learning (BMR, 2012). However, their perceptions of using cell phones with internet services in Physical Sciences learning still need to be gauged in order to facilitate smooth implementation. The TRA and TAM, explained in sections 2.2.2 and 2.2.3 respectively, emphasize the need to understand the attitude and behaviour of users before implementing new technology.

2.3.6 Attributes of mobile phones in Physical Sciences learning

Physical Sciences learning can be enhanced through using cell phones with internet services as a learning aid. According to Baya'a and Daher (2009), the following attributes of mobile phones with internet services apply to Physical Sciences learning:

- ❖ exploring Physical Sciences independently;
- ❖ learning Physical Sciences through collaboration and teamwork, where the collaboration is on equal terms;
- ❖ learning Physical Sciences in a social and humanistic environment;
- ❖ learning Physical Sciences in an authentic real-life situation;
- ❖ visualizing Physical Sciences and investigating it dynamically;
- ❖ carrying out diversified Physical Sciences activities using new and advanced technologies; and
- ❖ learning Physical Sciences easily and efficiently.

From the above attributes, it seems that mobile phones with internet services are quite relevant in facilitating Physical Sciences learning. Furthermore there other advantages

that can be attributed to mobile phones' usage. Quinn (2000), Mellow (2005), Iddris (2006) and Wentzel, van Lammeren, Molendijk, de Bruin and Wagtendonk (2005) concur that such handheld devices provide a cheap alternative to personal computers in a format that can easily be taken out of workplace at anytime and anywhere. In high school, learning is encouraged both inside and outside the classroom with the ability to link to activities that do not correspond with the teacher's agenda or the curriculum (Nokia Conversations, 2012), and Holzinger, Nischelwitzer, and Meisenberger (2005) point out that mobile phones are:

- ❖ easily available to the learners;
- ❖ linked to the internet wirelessly;
- ❖ highly portable, so the result can be at the fingertips of the user;
- ❖ able to collect data by accommodating a wide variety of peripheral extensions;
- ❖ equipped with much of the computing capability and expandable storage capacity of laptops at a fraction of the cost (Dieterle, Dede & Schrier, 2007); and
- ❖ easy, fast, convenient and interesting to use (Duncan-Howell & Lee, 2007).

Mobile technologies in education provide detailed and individual information about each learner such as gender, age and usage profile (UNESCO, 2012; Turuen, Syvänen & Ahonen, 2001; Nyiri, 2002). Educators can interact directly with learners while at the same time receiving responses from a learner anywhere and at any time (Nokia Conversations, 2012; Frand, 2000). The BMR (2012) and Prensky (2010) point out that mobile phones are by their nature more personal and private than computers and that as a result they receive much more attention from learners.

Botha, Herselman and van Greunen (2010) describe the mobile channel as immediate, automated, reliable, discreet and user-friendly. SMSs can be sent out automatically and in bulk to large groups of learners and fewer resources are required to activate the communication (Vanska & Robertson, 2011).

In the view of Botha *et al.*, (2010), mobile technology is time-sensitive, cheap and very reliable in delivering messages to learners. For example, a school can send

information such as reminders on assignments and projects, examination timetables, examination marks, important notices and campus news by SMS to learners (BMR, 2012; Botha *et al.*, 2010). In addition, messages can be searched for by data content and destination number. This allows full tracking and reporting, which permits a school to exercise control (Botha *et al.*, 2010). The TRA (section 2.2.2) and TAM (section 2.2.3) also explained advantages as pivotal to the acceptance of cell phones in teaching and learning.

2.3.7 Limitations of mobile phones in learning Physical Sciences

Nevertheless, mobile phones carry disadvantages that reduce their effective and efficient use. The following are some of them.

- ❖ The mobile devices have small screens, which limits the amount and type of information they can display (Maniar, Bennett, Hand & Allan, 2008).
- ❖ Storage capability is small and sometimes cannot be used by other applications.
- ❖ Their batteries need frequent recharging (BMR, 2012).
- ❖ There is no common platform or bandwidth (Haghirian, Madlberger & Tanuskova, 2005).
- ❖ Cell phones pose security risks (theft, pornography and exploitation) and are costly and addictive (BMR, 2012).
- ❖ Connection speeds are slow and the processing is generally weaker than that of desktops (Haghirian *et al.*, 2005; Stead *et al.*, 2006).

However, the disadvantages of mobile phones seem to be outweighed by their advantages. Paul (1995) points out that technology is not a neutral tool but a value-laden culture that must be both understood and taken into account in any attempt to change organizations. The TRA (section 2.2.2) and TAM (section 2.2.3) maintain that perceived disadvantages can lead to technology's not being used. Therefore the advantages and disadvantages of cell phones must be critically examined before mobile technology is integrated into the teaching and learning of Physical Sciences.

2.3.8 M-learning (mobile learning) and e-learning (electronic learning)

Figure 2.4 depicts the interrelatedness of mobile, electronic, and distance learning (d-learning). M-learning is a subset of e-learning, which in turn falls under d-learning. Therefore m-learning and e-learning are both part of d-learning. However, the boundary between m-learning and e-learning is not clear (Traxler, 2005).

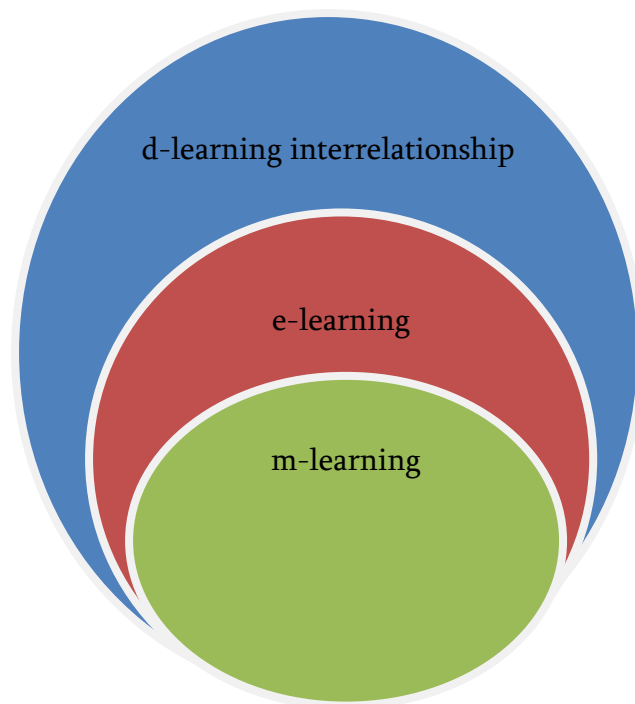


Figure 2.4: M-learning, e-learning and d-learning interrelationship (Georgiev, Georgieva and Trajovski, 2006)

M-learning can be defined as any sort of learning that happens when the learner is not at a fixed, predetermined location, or that happens when the learner takes advantage of the learning opportunities offered by mobile technologies (Mitra, Lenzmeier, Steffensmeier, Avon, Qu & Hazen, mobiLearn 2005; Geddes, 2004; Siraj, 2005). In other words, m-learning focuses on the mobility of the learner and the general population and increases their interaction through portable technologies (Mitra *et al.*, 2005). Dieterle *et al.*, (2007), Traxler (2005) and Caudill (2007) add that m-learning encompasses the array of handheld devices such as Personal Digital Assistants

(PDAs), tablets, mobile phones, laptops and other handheld information technology devices that may be used in teaching and learning.

E-learning's content, on the other hand, is defined as any educational information that is delivered electronically to educate, train or coach (Maniar, 2007). Wiley (2002) and Rosenberg (2001) agree that e-learning depends on computer networks capable of giving instant feedback. The computers can store information and distribute it to learners. Georgiev *et al.*, (2006) and Maniar (2007) conclude that m-learning is a subset of e-learning. However, Maniar (2007) states that m-learning differs from e-learning in the following ways: m-learning is more personal, more fun, more interactive, networked, spontaneous, of shorter duration, direct and to the point, just-on-time learning, engaging users to contribute and share, and direct from producer to user.

Nonetheless, m-learning is part of e-learning because it uses portable electronic devices and is accessible anywhere and at any time through wireless connections (Prensky, 2013; Walton, 2009). Learners can learn Physical Sciences concepts anywhere they go with no need to carry a heavy load of textbooks (Wang, Chen & Fang, 2011; Chen *et al.*, 2010).

2.4 CHAPTER SUMMARY

This chapter started by explaining the theories that form the foundation of this study. To this end, the adoption theory was dealt with, covering the theory of reasoned action (TRA) and the technology acceptance model (TAM). Empirical evidence was discussed, drawing views from authorities who have contributed to our knowledge of mobile technology usage in the education arena. Diverse resources were used which included extracts from journals, books, dissertations by other authors and the internet in an attempt to come up with balanced different views. It was noticed that various authorities agree that today's learners like cell phones and need them for social and academic purposes. Thus cell phones can open up new possibilities for efficient and effective learning and teaching in high schools.

The following chapter looks at the research methodology. This includes the research design, data-collection tools, analysis of data and presentation that were used for the study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Chapter 1 identified the gap that this study seeks to address, while Chapter 2 provided a survey of the literature on mobile learning and the use of cell phones as instructional tools. The purpose of this chapter is to present the research design. The chapter provides a detailed discussion of and justification for the selection of the design, techniques and procedures used to collect and analyse the data.

Figure 3.1 below outlines the theories that directed and informed the researcher on this study. The diagram shows cyclic stages that were followed during the research process. For example after coming up with the research methods the researcher had to review related literature again and revise the research methodology. After data collection and analyzing the researcher found the need to compare the findings with those of other researchers who did similar studies. Researcher assessed the effectiveness of the research methods under this study

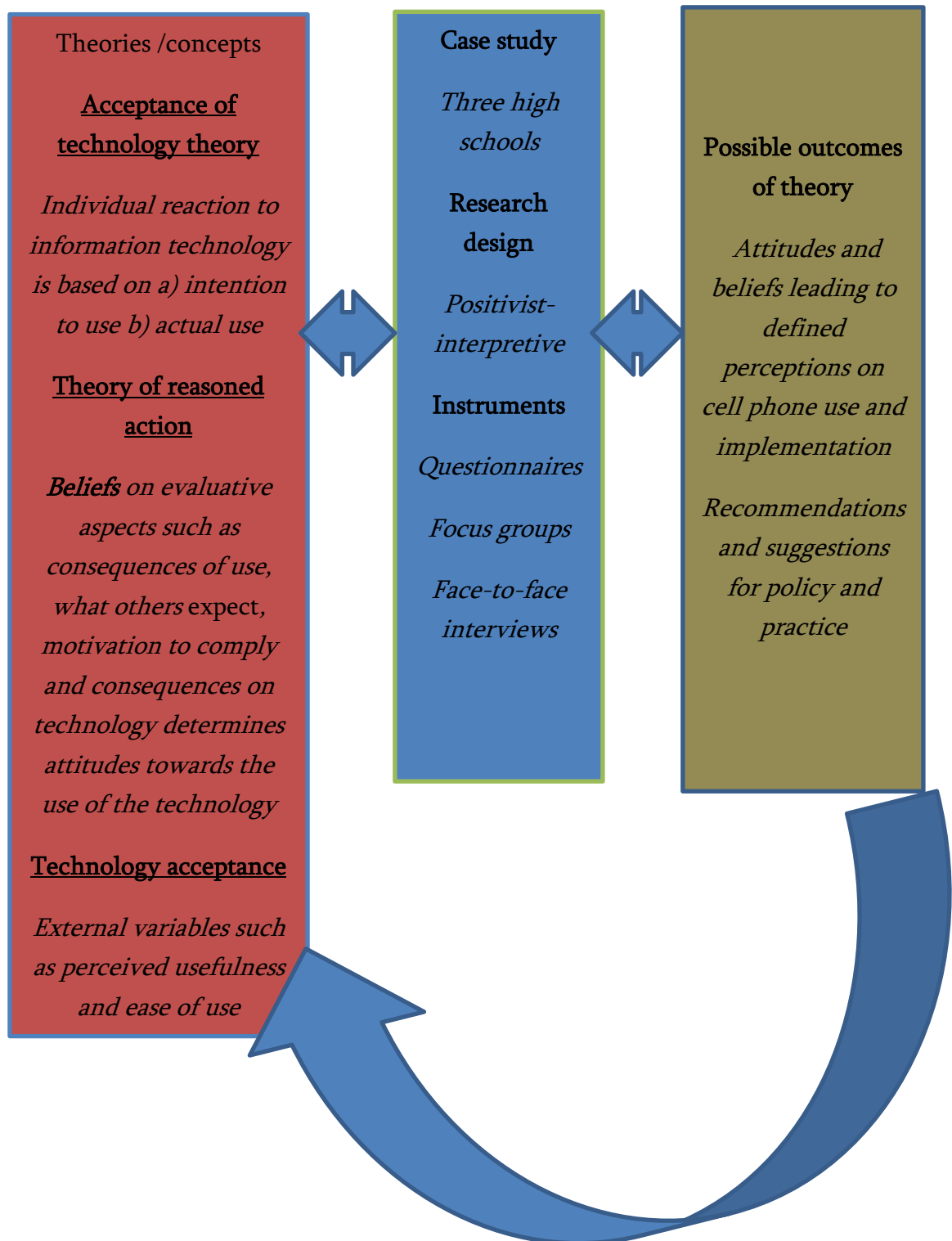


Figure 3.1: Research design (Mixed methods)

Adapted from Chirove (2015:87)

The research onion below offers a comprehensive and sequential road map that guided and directed the depth and coverage of the chapter (see figure 3.2)

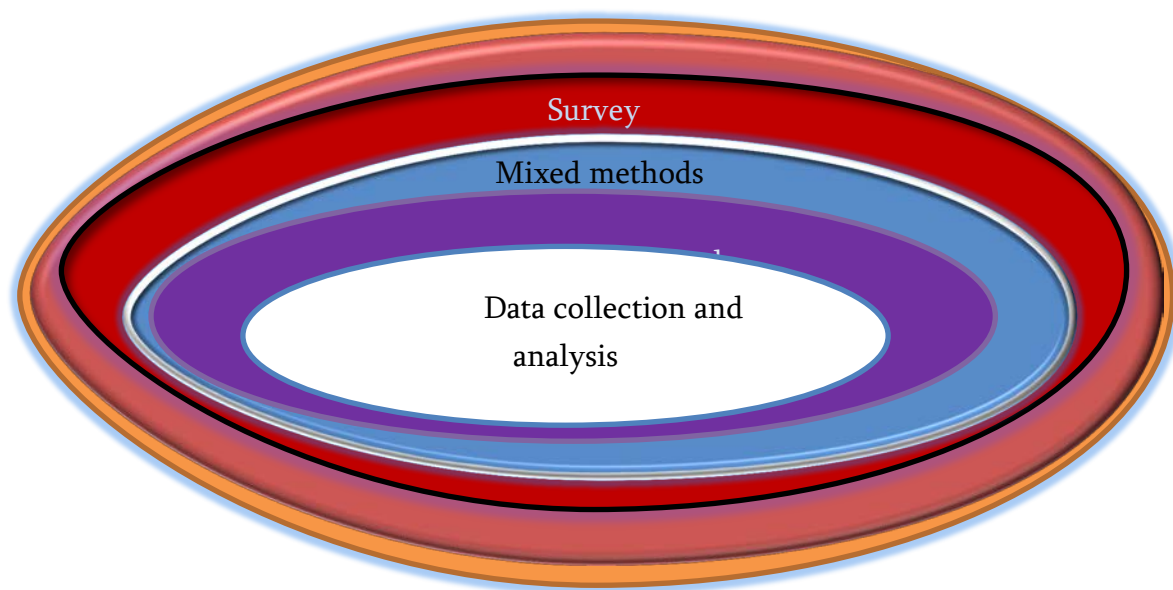


Figure 3.2: Research onion depicting an overview of Chapter 3 (Saunders, Lewis & Thornhill, 2009)

The chapter describes sampling methodology in terms of the target population, sampling frame, sampling method and size. Thereafter, the questionnaire and interview schedule used to collect data are explained and validity and reliability are discussed (Golafshani, 2003). The strengths and weaknesses of a questionnaire and an interview are explained in order to clarify and justify the selection and its suitability to the research. The measures taken to minimize the weaknesses of a questionnaire and an interview are spelt out. Data-collection procedures and data presentation and analysis procedures are explored. A description of the problems and limitations relevant to this research is given.

3.2 THE RESEARCH DESIGN

The research design focused on the plan used in the research study. Aaker, Kumar and Day (1998) explain a research design as a detailed blueprint used to guide a research study towards its objectives. Mwirira and Wamahius (1995), Gray (2009), Gratton

and Jones (2010) and Creswell (2012) state that a research design is an overall plan for enhancing the researcher's internal and external plan in order to improve the research's internal and external validity. McMillan (2007) and Ngulube (2013) add that research design embraces techniques or tools for generating thorough, accurate and ethical data and strategies for data collection. In other words, research design refers to the theoretical framework under which the study is carried out. To satisfy the information needs of any study, an appropriate methodology has to be selected as well as suitable tools for data collection (Wiersma & Jurs, 2008; Saunders, Lewis & Thornhill, 2009; Creswell, 2012).

This study used the mixed-method approach in order to strengthen and complement the findings obtained by questionnaire through further probing using interviews in sequential order. Proponents of mixed methods, such as Creswell (2012) and Ngulube (2013), say that mixed methods combine the strengths of both qualitative and quantitative research methods. The explanatory sequential method design was used (see figure 3.3 below). The researcher used qualitative data from interviews to complement quantitative data collected through questionnaires (Creswell, Klassen, Plano Clark & Smith, 2011; Ngulube, 2013). Furthermore the researcher used a positivist-interpretive paradigm since the study involved the use of both quantitative and qualitative data sources (Ngulube, 2013).

3.2.1 Descriptive design

Descriptive design entails the use of scientific and systematic approaches such as the quantitative and qualitative approaches (Creswell *et al.*, 2011; Ngulube, 2013). According to Gall, Borg and Gall (1996), the descriptive design describes form, structure and activity, change over time and relationship to other phenomena. In this study, the descriptive design that was used involved mixed approaches to gathering data. According to Creswell *et al.*, (2011), descriptive design involves mixed approaches in a triangulation format. In this study quantitative and qualitative data were collected using questionnaires and interview schedules respectively. Figure 3.3 below outlines the sequence of the mixed-method research design.

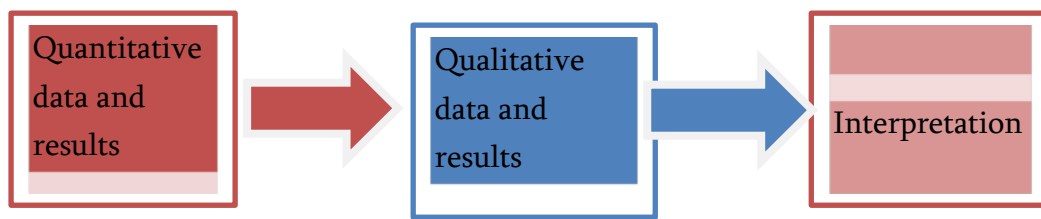


Figure 3.3: Explanatory sequential research design (Creswell *et al.*, 2011)

In the descriptive research design, the researcher focused on learners' and educators' perceptions of the use of mobile phones in the learning of Physical Sciences. Quantitative data collected via questionnaires formed the primary source while qualitative data collected from interviews formed the secondary source. At the end, the results of all the data collected were used to interpret and draw conclusions on learners' and educators' perceptions of the use of cell phones with internet services in the teaching and learning of Physical Sciences in high schools in the Moretele area.

The researcher selected the descriptive research method because of its merits in procedures for collecting raw data. The descriptive research method creates data structures that describe the existing characteristics, such as attitudes, intentions, preferences, behaviours and evaluations, for a defined target population (Hair, Bush and Ortinau (2000); Creswell, 2012). Scholars like Borg and Gall (1998) and Best and Khan (2003) agree in epitomizing a descriptive method as one that specifically describes what one sees. The researcher chose the descriptive survey method for the above-mentioned reasons given by Hair *et al.*, (2000) and a variety of other reasons, including those given by Borg and Gall (1998) and Ngulube (2013), which involve the description, recording, analysis and interpretation of conditions that exist. More importantly, by using the descriptive survey design it is easy to gather systematically empirical data from both the learner and the educator (Ngulube, 2013; Creswell 2012; Borg & Gall, 1998).

In this study, the population chosen was assumed to represent the perceptions of the educators and learners of high schools in the Moretele area who used cell phones with internet services in the teaching and learning of Physical Sciences. Since descriptive

design takes a detached stance towards the recipients and their setting (McMillan & Schumacher, 2010; Creswell, 2012), the researcher could form valid deductions, interpretations and conclusions on the perceptions of the respondents.

However, it is important to note that in spite of the above-mentioned laudable strength of the descriptive survey plan, it also has drawbacks. Hair *et al.*, (2000) cite its lack of predictive power as the major disadvantage of the descriptive survey method, while Ngulube (2013) observes that the descriptive survey talks of the present but fails to project into the future to give a generalization. In this study, in order to overcome the problem of lack of prediction, the researcher considered the responses of both the teachers and the learners who started mobile learning as from 2012 to 2014 and checked their consistency in terms of responses and numbers.

McMillan and Schumacher (2010) and Leedy and Ormrod (2005) note that the survey research design may be susceptible to distortion through the introduction of bias. Ary, Jacobs, Razavieh and Sorenson (2009) say that the wording of questions in descriptive design is challenging. In order to minimize the weakness of the descriptive research design pointed out by Leedy and Ormrod (2005) and Ary *et al.*, (2009), the researcher used a mixed approach to gather quantitative and qualitative data in a sequential order (Ngulube, 2013). The researcher also took the greatest care in drafting the questionnaires to ensure that they did not contain ambiguous terms or suggestive and leading phrases. In addition, the project supervisor and a colleague moderated the questionnaires to ensure that they were clear, concise and reliable. Furthermore, a pilot testing was carried out with a school not involved in the study to ensure both inter-item and test-retest reliability (Denzin, 2000; Hennessy *et al.*, 1989; Creswell *et al.*, 2011). Interviews were prepared with open-ended questions, and during interviews the researcher maintained neutrality by avoiding bias, subjectivity and suggestive phrases.

In summary, the major intention of this study was to offer a descriptive and enlightening view of the readiness, attitudes and perceptions of educators and learners towards the use of cell phones in the teaching and learning of Physical Sciences.

3.2.2 Quantitative and qualitative approaches

Hair *et al.*, (2000) and Merriam (2009) state that primary data embrace raw data and structures of variables that specifically collect and assemble current information on a research problem. In other words, primary data sourced for the specific purpose of solving a problem identified may be quantitative or qualitative (Malhotra & Birks, 2006; McMillan, 2007; Creswell *et al.*, 2011; Ngulube, 2013). In this research, both qualitative and quantitative methodologies were used in a sequential approach. Methodical triangulation was used, which involved comparing and contrasting data gathered by questionnaire and interviews. The two data sets from questionnaires and interviews were merged. This was done to strengthen the collected data and diminish the weakness of the questionnaire. In other words, the findings from the questionnaires were reinforced by findings from interviews in order to arrive at convergent findings (Bryman, 2011; Creswell, 2012). Quantitative data were collected first, using questionnaire answers as the primary data set. The results from the questionnaire informed the collection of the second data set, which came from the interviews. The interviews collected qualitative data that played the secondary role of adding value to, complementing, and dispelling some of the questionnaire findings (Patton, 2002;; Creswell, 2012). As embedded in the design, it was assumed that the qualitative data set would be supplementary to the primary data set (Ngulube, 2013). The researcher used the qualitative approach so that the respondents would be able to reflect and express their feelings and opinions in a natural manner (Patton, 2002; Malhotra & Birks, 2006).

In this study, the researcher gauged qualitatively the opinions, experiences, attitudes, values and interpretations among other responses the respondents gave regarding the use of cell phones with internet services in the teaching and learning of Physical Sciences. The researcher remained sensitive and receptive to unplanned questions or additional questions during the interview sessions. The focus was on soliciting information about the readiness, acceptance, attitudes and perceptions of respondents. The researcher was concerned also with how respondents chose their words and the meanings they gave to their experiences (Merriam, 2009; Creswell, 2012). The researcher probed the participants' responses during the interviews in order to gather more in-depth data on their interests, feelings, experiences and perceptions regarding

the use of cell phones with internet services in the teaching and learning of Physical Sciences (Gay & Airasian, 2008). The researcher was sensitive about the tone of his voice, choice of words and perspectives in order to give the correct impression of the authenticity and trustworthiness of the study.

In this study, the quantitative approach emphasized the use of formalized standard questions and predetermined response options in questionnaires administered to large numbers of respondents (Hair *et al.*, 2000; Ngulube, 2013). The researcher used the questionnaires to solicit statistical data quantitatively to provide facts in making predictions and to gain meaningful insights into learners' and educators' perceptions of the use of cell phones (Hair *et al.*, 2000; Creswell *et al.*, 2011). The interviews followed to reinforce or counteract some of the responses given in the questionnaires.

3.3 POPULATION AND SAMPLE

The study focused on Grade 10, 11 and 12 Physical Sciences learners and educators in schools in the Moretele area who were using cell phones with internet services in the teaching and learning of Physical Sciences. Ngulube (2013) and Creswell *et al.*, (2011) state that a research sample consists of individuals selected from a larger group of persons known as the sample's population. The population for this research study consisted of 360 Physical Sciences learners and 12 Physical Sciences educators from three high schools. These three schools were selected because:

- ❖ they were nearer to the researcher's home;
- ❖ the researcher was familiar with these schools;
- ❖ they were convenient to the researcher;
- ❖ all three schools were using cell phones with internet services in the delivery of Physical Sciences lessons; and
- ❖ the three schools were willing to participate in the survey.

This typifies the selection of the sample as convenient (Leedy & Ormrod, 2005; Wiersma & Jurs, 2008; Creswell *et al.*, 2011).

For the collection of quantitative data a sample was selected consisting of 345 learners in Grades 10, 11 and 12 and nine educators. These participants were selected because they wanted to participate and were all using cell phones with internet services in the teaching and learning of Physical Sciences. The 345 learners were selected using the random sampling technique. The random selection was done using small, equally- sized cards labelled “Yes” or “No”. The cards were thoroughly mixed in a box and each learner was asked to close his or her eyes and pick at random one card from the box, which was held up by the researcher. A “Yes” card meant participation while a “No” card meant non-participation. The nine educators, however, were selected purposely as they had the most experience and were willing to participate. The learners and the educators in the above sample provided the mainly quantitative data gathered via questionnaires in phase 1 of the data collection.

The second phase of data collection saw qualitative data being collected via focus-group interviews with learners and scheduled interviews with educators. In this phase, 45 learners were selected in two stages from the first sample of 345 learners. The criteria for first-stage selection were willingness to participate and good knowledge of cell-phone use. Those who met these criteria were then asked to pick at random a card from a box, as described above, and those who picked the “Yes” cards participated in the focus-group interviews. A total of 45 learners were selected for phase 2 and were then interviewed in groups of five of their choice.

From the nine educators in phase 1 of the data collection, three were selected by the researcher for phase 2 on the basis of the extent of their relevant teaching experience and also their willingness to participate. The three most experienced (and willing) educators were then individually interviewed in their places of choice.

3.4 RESEARCH INSTRUMENTS

Mouton (1996) states that in any research or investigation a suitable tool for data collection needs to be chosen. Ngulube (2013) and McMillan and Schumacher (2010) say that research instruments are tools that the investigator uses for collecting data aimed at finding a solution to the problem. In this research, the questionnaires and interviews with learners and educators were used to collect raw data. Questionnaires

were used because the targeted respondents were educators and learners, who were all considered to be literate.

Focus-group interviews were conducted with 45 purposely selected learners as a follow-up means to gather in-depth data. The focus-group interviews were done after analysing data collected via the questionnaires. On the other hand interviews were carried out with three educators deliberately selected on the basis of their experience. This was done to clarify questions of interest not properly covered by the questionnaire and to get a deeper understanding of their readiness, feelings, beliefs and perceptions regarding cell-phone usage in the learning and teaching of Physical Sciences.

Before administering the research instruments to the target population the researcher carried out a pilot study with a sample of 30 Grade 10, 11 and 12 learners and two educators at another school, i.e. one outside the study. This pilot testing was done to refine the questionnaires so that respondents would have no problem in answering the questions and recording the collected data (Saunders *et al.*, 2009). The researcher administered the questionnaire to both the learners and the educators on the same day and analysed the results. Three days after the first contact the researcher visited the same school again and conducted learner focus-group and educator interviews. After that, the results obtained were analysed and interpreted and relevant adjustments to the research instruments and procedures were made for the smooth running of the primary research (see Appendices IX, X, XI and XII).

3.4.1 Questionnaire

The questionnaire was the primary instrument used to gather relevant data for analysis for the first phase. The questionnaires collected three types of variable data: opinion, behaviour and attitude (Dillman, 2007). The researcher used questionnaires because of the following advantages they have.

- ❖ A questionnaire is economical as hundreds can be administered at one time.
- ❖ A questionnaire is impersonal and anonymous.
- ❖ There is no halo effect in a questionnaire.

- ❖ The presence of the investigator is not necessary, which promotes more honest responses.
- ❖ A questionnaire is more suited to gathering data involving people's feelings, attitudes and opinions.
- ❖ A questionnaire may be easily summarized and analysed.
(Creswell *et al.*, 2011; Cohen, Manion & Marrison, 2000).

Nevertheless the strength of the questionnaire does not mean that this instrument is flawless. The following are some of the disadvantages of the questionnaire.

- ❖ Low response rates can occur, especially when less educated respondents and older people are involved.
- ❖ There may be no assurance that the addressee was actually the one who answered the questions.
- ❖ There is no assurance that the respondents understood the questions.
- ❖ It does not give room to clarify uncertainties.
- ❖ There is a high risk of the loss of questionnaires in transit.
(Ngulube, 2013; Creswell *et al.*, 2011; Seale, 1998)

In an attempt to minimize the weakness of the questionnaire the researcher had to put in place a number of solutions. For example, in order to eliminate ambiguity in questions a pilot study was carried out and moderation of items was done by a colleague and the research supervisor. Unclear and invalid questions discovered were corrected or removed. To ensure a big return, research assistants were appointed who followed up on every respondent in each school. The use of research assistants helped to cover up the identity of the researcher, to minimise subjective judgement, ensure anonymity and confidentiality. The research assistants clarified questions from the respondents when they needed explanations.

In addition the questionnaires were made short and neat, and did not include questions that might ridicule or embarrass the respondents (Creswell *et al.*, 2011). In structuring the questionnaires, questions relating to attitudes were presented at the beginning, followed by questions on opinion and behaviour. The last section concentrated on behavioural variables in the perceptions and attitudes of learners and

educators (see Appendices IX & X). Since the aim of the research was to find out the perceptions of learners and educators regarding cell-phone learning in the study of Physical Sciences, the majority of the questions were rating questions. There were checklists, attitude scales and projective techniques or rating scales in the questionnaire (Creswell, 2012; Ngulube, 2013). This helped in statistical analysis. The researcher developed two different questionnaires, one for the Grades 10, 11 and 12 Physical Sciences learners and the other for the Physical Sciences educators. Each questionnaire included eight items designed to measure the respondent's readiness, experiences, attitudes and perceptions in relation to the use of mobile wireless technology.

The questionnaire consisted of eight questions of the open-ended or closed type, and 18 questions of the rating-scale type (see Appendices IX & X). A five-point Likert scale with *strongly agree*, *agree*, *undecided*, *disagree* and *strongly disagree* was used for the main items. This approach is frequently used in distance education (Roberts, Iran, Telg & Lundy, 2005).

3.4.1.1 Reliability

3.4.1.1.1 Learners' questionnaire

The researcher measured the reliability of 18 items of the closed-form questionnaire for the learners by calculating Cronbach's alpha on each factor (see table 3.1).

Table 3.1: Extracts of reliability coefficients on four factors that represent learners' perceptions of cell-phone use

Factor	Cronbach's alpha	Cronbach's alpha based on standardized items	Number of items
1	0.710	0.719	6
2	0.738	0.736	6
3	0.809	0.805	4
4	0.364	0.366	2

Cronbach's alpha is based upon the average correlation among the items in a scale (Cronbach, 1951; Arbaugh, Bangert & Cleveland-Innes, 2010). The reliability coefficients given in table 3.1 revealed that the items demonstrated sufficient levels (alpha 0.70 or greater) of internal consistency reliability (Arbaugh *et al.*, 2010; George & Mallery, 2003). Factor 1 consisted of six questions with a theme of perceived usefulness and had a reliability coefficient of $\alpha=0.719$. Similarly factor 2 consisted of six questions with a theme of perceived attitudes and beliefs and factor 3 consisted of four questions with a theme of perceived disadvantages. Their reliability coefficients were $\alpha=0.738$ and $\alpha=0.809$ respectively. The Cronbach's alpha for the scale scores of the first three factors was fairly good as they ranged from 0.710 to 0.805 (George & Marley, 2003). Factor 4 consisted of two questions with a theme of perceived influence from outside and had a reliability coefficient of $\alpha=0.364$. Factor 4 had a low reliability coefficient, probably because it contained only two items. The average of the reliability coefficients of the four factors was 0.706. This was greater than 0.700 and as a result the researcher concluded the questionnaire to be a reliable instrument (see table 3.2).

Table 3.2: Average reliability statistics for the four factors

Cronbach's alpha	Cronbach's alpha based on standardized items	Number of items
0.706	0.740	18

3.4.1.1.2 Educators' questionnaire

Similarly, the researcher measured the reliability of 18 items of the closed-form educators' questionnaire by calculating Cronbach's alpha on each factor. Table 3.3 below shows the average of the combined 18 items' coefficients for the closed-form questionnaire.

Table 3.3: Average reliability statistics from the educators' closed-form questionnaire

Cronbach's alpha	Cronbach's alpha based on standardized items	Number of items
0.759	0.833	18

The table gives the average of the combined 18 items' coefficients of the questionnaire to be 0.759, which is greater than 0.700. As a result the researcher considered the questionnaire for the educators to be a reliable instrument (Cronbach, 1951; Arbaugh *et al.*, 2010).

3.4.2 Convergent and discriminant validity

The researcher used convergent validity tests to establish the existence of a relationship between variables that were expected to be related (Golafshani, 2003; Shuttleworth, 2009). In addition to that, discriminant validity tests were used to ascertain that the variables that should not be related were not related at all. To assess both the convergent and the discriminant validity of learners' and educators' perceptions as gleaned via the closed-form questionnaire instrument, the researcher computed the correlation coefficients between the factors and represented them in a form of matrix (see table 3.4).

Table 3.4: Extract of matrix of correlations between factors

		Factor 1				Factor 2				Factor 3			
		Q21	Q20	Q15	Q19	Q10	Q12	Q11	Q13	Q23	Q25	Q24	Q22
Factor 1	Q21	1	0.356	0.375	0.334	0.03	0.154	0.17	0.196	-0.057	0.033	0.012	-0.081
	Q20	0.356	1	0.407	0.324	0.082	0.217	0.211	0.34	0.016	0.054	-0.027	0.041
	Q15	0.375	0.407	1	0.25	0.171	0.165	0.238	0.348	0.105	0.089	0.048	-0.033
	Q19	0.334	0.324	0.25	1	0.105	0.155	0.202	0.271	-0.177	-0.08	-0.169	0.033
Factor 2	Q10	0.03	0.082	0.171	0.105	1	0.423	0.422	0.301	0.029	-0.022	-0.026	0.016
	Q12	0.154	0.217	0.165	0.155	0.423	1	0.453	0.343	-0.02	-0.108	-0.091	0.011
	Q11	0.17	0.211	0.238	0.202	0.422	0.453	1	0.295	-0.063	-0.121	-0.095	-0.087
	Q13	0.196	0.34	0.348	0.271	0.301	0.343	0.295	1	0.049	-0.039	-0.11	0.017
Factor 3	Q23	-0.057	0.016	0.105	-0.177	0.029	-0.02	-0.063	0.049	1	0.677	0.641	0.381
	Q25	0.033	0.054	0.089	-0.08	-0.022	-0.108	-0.121	-0.039	0.677	1	0.689	0.338
	Q24	0.012	-0.027	0.048	-0.169	-0.026	-0.091	-0.095	-0.11	0.641	0.689	1	0.322
	Q22	-0.081	0.041	-0.033	0.033	0.016	0.011	-0.087	0.017	0.381	0.338	0.322	1

Key

Convergent coefficients: Factor 1 **Factor 2** **Factor 3**

According to Trochim (2006), the correlations between items that measure the same thing should be high. On the other hand correlations between items that measure different things should be low. In general there is a distinct cut-off point as to how high or low the correlations should be. However, it is expected that the convergent correlations should be higher than the discriminant correlations (see table 3.4). Table 3.4 shows that in extracts of correlations, inter-correlations between items of factor 1 are higher than the correlations between items of factor 1 and other factors. Furthermore, correlations between items of factor 2 are higher than the correlations between items of factor 2 and other factors. The existence of higher correlations between items within the same factor indicates that they are converging on the same thing. Conversely, lower correlations between items of different scales indicate that the sets of scales are discriminated from each other (Trochim, 2006). The highlighted blocks in table 3.4 on the extract of matrix of correlations represent the convergent coefficients. In table 3.4 it is shown that the convergent coefficients are higher than the discriminant ones. As a result the correlation matrix provides some evidence for both convergent and discriminant validity. The researcher used this evidence to ascertain the validity of the questionnaire instrument (Trochim, 2006; Shuttlesworth, 2009).

3.4.3 Learner focus-group interview

Grade 10, 11 and 12 Physical Sciences learners were involved in focus-group interviews at each of the three selected high schools. This was done as a follow-up strategy to complement data collected using a questionnaire. There was a total of 45 learners, from whom nine groups were made consisting of five learners each. The focus-group interview was chosen purposely to use communication between research participants in order to generate more data. The selected groups were small enough to allow genuine discussions among all the recipients (Wiersma & Jurs, 2008). Learners of similar ages who associated well and had good cell-phone use experiences were purposely selected for focus-group interviewing (Creswell *et al.*, 2011).

In addition, learners who were friends and those who volunteered to participate were chosen for focus-group interviewing because they were assumed to be free and open

to discuss questions together (DeVellis, 1991; Ngulube, 2013). In the focus-group interviews participants were encouraged to talk to one another, asking questions, giving explanations and commenting on each other's experiences and points of view (Wiersma & Jurs, 2008).

However, learners were discouraged from passing bad comments to each other or saying anything that would upset any member of their group. Questions were designed so that they contained key words such as *what, how, when, why, which, under what conditions, where* and similar probes so that a deeper knowledge and understanding would be obtained (McMillan & Schumacher, 2010). The focus-group interviews were intended to solicit information on learners' attitudes, beliefs and/or perceptions regarding cell-phone use in the teaching and learning of Physical Sciences (see Appendix XI). For example, the first question asked about the advantages or what was good in using cell phones with internet services in learning Physical Sciences. A response which said that cell phones provided a variety of learning resources showed a positive attitude towards their usage or their advantages. The second question focused on what was bad about using cell phones in Physical Science learning. In this question negative attitudes towards or disadvantages in the use of cell phones were determined. For example, a response which said that learners would use cell phones for cheating during examinations or that poor network would disrupt lesson progress reflected negative perceptions of the use of cell phones. The third question asked whether cell phones should be used for Physical Sciences learning and teaching in all schools. This question focused on the adoption of cell phones. Responses such as "Yes, cell phones would make learners pass Science" or "Cell phones give better service than an educator" reflected positive beliefs about the adoption of cell phones in the teaching and learning of Physical Sciences. In addition, the researcher commenced with general questions and then moved on to the more specific ones in a smoothly connected progression.

All in all, the interviews strengthened the findings of the questionnaire, thereby making the results of the study valid and reliable. The findings of the instruments complemented each other, which probably adds weight to the study.

3.4.4 Educators' interview

Face-to-face interviews were carried out as a follow-up on the educators' questionnaire results, using three purposely selected educators. The interview was semi-structured and consisted of four open-ended questions. The questions were designed to determine the interviewees' experience, knowledge, attitudes, beliefs and ideas regarding the implementation of cell-phone teaching and learning (see Appendix XII). The first two questions inquired about what is good and bad in using cell phones in the learning and teaching of Physical Sciences. These questions sought to determine the interviewees' attitudes, beliefs and/or perceptions regarding cell-phone use. For example, replies which said that learners get quick responses to their questions reflected positive attitudes, while responses such as "Cell phones improve pass rates in Physical Sciences" showed positive beliefs. However, responses such as "Learners get addicted to cell phones" or "Learners use cell phones for criminal activities" indicated negative perceptions of the use of cell phones.

The third question concerned beliefs and implementation. It elicited information on the interviewees' attitudes towards the implementation of cell-phone learning. For example, responses such as "Yes, cell-phone learning should be implemented because the world is getting computerized" reflected a positive attitude towards implementation, whereas a response which said "No, cell phones should be limited to referencing purposes because they might promote criminal activities" reflected negative attitudes towards full implementation.

The fourth question focused on the best ways of adopting cell-phone learning and teaching of Physical Sciences. Responses such as that educators and learners should be given training in the correct use of cell phones in teaching and learning, or that functions which distract from learning, such as WhatsApp, Facebook, We-Chat and Twitter, should be removed, indicated positive attitudes towards adoption.

The advantages of using the interview schedule were:

- ❖ to permit face-to-face interaction;
- ❖ to build rapport with the interviewees;

- ❖ to seek clarification on some of the answers in the questionnaires;
- ❖ to enable probing of inadequate responses;
- ❖ to monitor non-verbal clues;
- ❖ to permit flexibility in the interview; and
- ❖ to get the reticent respondents to be more forthcoming, so that more information could be uncovered on cell-phone usage in Physical Sciences teaching (McMillan & Schumacher, 2010).

One weakness of interviews is their lack of anonymity, which may cause the respondents not to yield up all their information (Barker, 1994). In addition, personal influence and bias on the part of the researcher may affect the validity of the findings: for example, the interviewer may empathize with responses that tally with his expectations while ignoring those that do not.

In order to minimize the weaknesses and build mutual trust the researcher had to clarify the purpose and procedure of the research. Consensus was sought after disclosing details of the research to the participants. During the interviews the researcher strove to be patient and polite, and avoided interjections whenever contributions were being made. The researcher asked clear and precise questions whenever he had to and was always a good listener.

During the interviews, the researcher probed participants in a polite manner with some extra questions not included in the research schedule in order to get a deeper understanding of specific issues in relation to the interviewees' responses. Interesting leads that emerged during the interviews were also discussed.

In general the interview schedule was not rigid but flexible. It was meant to guide the researcher on the types of questions he had to ask to remain focused on the main objectives of the study.

The interview schedule was used to try to complement and add more value to the questionnaire in this study.

3.4.4.1 Validity of the interview

Validity can be viewed as a fit between what the researcher records as data in the study and what actually occurs at the setting under study (Chirove, 2015). The researcher had to give a detailed record of what took place at the site of the research. He used multiple sources of data to enable him to triangulate and interpret converging evidence. For example, data collected from interviews and questionnaires were cross-validated through converging validity. Converging and diverging responses were noted and interpreted. According to Creswell *et al.*, (2011) and Ngulube (2013), conclusions suggested by different data sources are far stronger than those suggested by one source alone. Therefore the use of the questionnaires and the interviews to collect data in this study improved the validity of the collected data. Reliability was then determined by the consistency of the responses the researcher got from the participants. In order to minimize variability in participants' responses, all the interviewees were subjected to similar conditions: for example, all the participants answered the same basic questions, which were worded and sequenced the same way. Also, all participants were given equal and identical platforms for expressing themselves freely.

3.5 DATA-COLLECTION PROCEDURE

Data were collected from Grade 10, 11 and 12 learners via questionnaires and focus-group interviews. In addition, via questionnaires and interview schedules data were collected from educators who were using cell phones in the teaching and learning of Physical Sciences. The use of the different methods for data collection provided validity and reliability checks within the study (Creswell *et al.*, 2011; Ngulube, 2013).

Before the fieldwork was undertaken, permission was sought from the Department of Education area office and the circuit managers and principals concerned. After obtaining the necessary permission, the researcher visited the targeted high schools and arranged the survey date with the educators and the learners. The researcher also selected research assistants from each school and agreed with them on procedures for the research. The researcher agreed arrangements with the research assistants on how the questionnaires would be dispatched and on the dates of their collection (Best &

Khan, 2003). The research assistants distributed the questionnaires to the participants on the day they were received and collected them the following day. The researcher also collected them from the research assistants on the agreed day. Responses from the questionnaire were analysed and new dates were set for follow-ups for further in-depth information using focus-group and face-to-face interview schedules. The researcher visited each high school once again on an agreed date and carried out both the focus-group interviews and the educators' interviews on the same day with the help of the research assistant.

In the following section the researcher explains how the research instruments were administered to the respondents.

3.5.1 Administration of the research instruments

3.5.1.1 Questionnaires

The research assistants administered the questionnaires to both the learners and the educators. The research assistants explained and elaborated on all areas that needed further explanations as well as the rationale for the study. The assistants told the participants that the data collected would be treated confidentially and analysed anonymously. To encourage truthfulness in the survey responses, the research assistants instructed the respondents not to write their names on the questionnaire. Participants were given a full day to complete the questionnaire. The research assistants collected the questionnaires the following day: all nine from the educators, and from the learners, 340 out of the total of 345 issued, with five questionnaires spoilt by the learners who had received them. The questionnaires sought to reveal the participants' experience, knowledge, beliefs, attitudes and views regarding cell-phone learning and teaching.

3.5.1.2 Focus-group interviews

The researcher conducted both the focus-group interviews with the learners and the face-to-face interviews with the educators with the assistance of the research assistants. Learners had the opportunity to choose groups they wanted to belong so

that they were comfortable and felt free to participate. Before doing the interviews the participants were given copies of the interview schedule questions to browse through. This gave them the opportunity to think, prepare and be ready to give in-depth responses to the questions. As a result the learners responded to the interview questions with excitement and confidence.

3.5.1.3 Face-to-face interviews

The same approach was used with the educators for the face-to-face interviews. The researcher gave the educators copies of the interview questions to go through beforehand. This gave the educators enough time to prepare their responses to the questions on the interview schedule and also to any further questions that might arise. As a result the educators managed to give detailed and candid responses. All the interviews were audio-recorded and transcribed by both the researcher and the research assistants.

3.6 INTERVIEW ETIQUETTE

During the focus-group interviews, the researcher took a neutral position even when the respondents exchanged views, comments or answers. The participants were given enough room to freely discuss and share their experiences. The researcher elaborated on the procedures of the interview and the need for freedom of expression. He emphasized that all responses provided were correct, and would be recorded anonymously. Every participant was encouraged to respect every contribution made. The researcher also had to consider and note down the concerns of the participants.

The interviews were carried out over an average period of 30 minutes per group. The interviews were slotted in during lunchtime and after school, depending on the groups' preferences. Questions were listed with spaces provided to write the answers in case the recorder malfunctioned. The interviews were conducted in venues selected by the participants where they felt free to express themselves without any hindrances or fear. Special attention was given to interview etiquette.

The researcher recorded all responses through his cell-phone and in written notes. Furthermore, during the interviewing the researcher strove to be objective, polite and

circumspect and to communicate without ambiguity. After the interviews were completed, the respondents were given the opportunity to ask final questions and make comments and suggestions. The researcher then thanked all the participants for their time, efforts and contributions.

3.7 ETHICAL MEASURES

McMillan and Schumacher (2010) point out that ethical responsibilities and legal constraints must govern the gathering and reporting of information in a study, so as to protect the rights and welfare of the participants. In this research, ethical protocol was followed and adhered to. This included sending covering letters, guaranteeing the right to withdraw and refuse to participate at any stage, giving the assurance of anonymity, getting permission letters, getting informed consent letters from the parents and assent letters from the children, guaranteeing everyone's right to privacy and protection from harm, and being honest with all participants.

A clear explanation of the purpose and procedure of the research was given before the study was carried out. Contact details of the researcher and supervisor were supplied. Data were collected in a professional, ethical, safe and secured research environment. At the end of the data collection all participants were thanked for their support and time. The researcher pledged his ethical responsibility of avoiding plagiarism and adhering to correct citation principles.

3.7.1 Informed consent and assent

The researcher wrote letters requesting permission to do research in Moretele high schools to the relevant authorities and to the principals of the individual schools concerned. The researcher wrote letters of consent in duplicate, which were signed by the parent or guardian. The contents of the letter were explained to the learner so that the learner was able to assist the parent or guardian if the need arose at home. The parent or guardian kept one signed copy and the other copy was returned to the researcher. The researcher gave learners of 16 years and above assent letters to read and sign. Where clarity was needed the researcher explained before they signed. The

researcher kept each signed copy and duplicate copies were given to the learners to keep.

The following Appendices contain the letters and consent form that were issued: I – permission letter to the Department of Education, II – permission letter to the principals, III – letter to prospective participants, IV – consent to participate in the study, V – letter requesting parental consent for minor, VI – letter requesting learner’s assent to participate in research, and VII – letter requesting an educator to participate in an interview.

3.7.2 Right to privacy

The researcher took the following measures to protect participants from harm and to ensure their right to privacy (McMillan & Schumacher, 2010). The data collected were not associated with any of the participants. Data collected were kept confidential and anonymous. The researcher made sure that completed questionnaires remained confidential and the research assistants were asked to put them in sealed envelopes. Audio records and notes from the interviews were not accessible to non-participants.

3.7.3 Protection from harm

The researcher constructed the questions in such a manner that they would not offend or harm the respondents in any way (Wiersma & Jurs, 2008). Furthermore, the researcher assured the participants that their views would remain confidential and would be used for academic purposes only. The participants were told about their right to withdraw freely at any time without any risk of punishment.

3.7.4 Honesty

To enhance its credibility, the results of the study would be made available to the participants, high schools, Department of Education area office and external audience upon request (Smith & Holian, 1999). The results of the study were for academic purposes only.

3.8 CHAPTER SUMMARY

This chapter has given the reader an insight into the descriptive design method employed with a mixed approach in gathering data for the study. The research instruments (questionnaires, focus groups and interview schedules) have been discussed, as have the criteria of sample units and data-collection procedure. In this research, data were collected using questionnaires, focus groups and face-to-face interviews in a sequential order. A total of 345 learners and nine educators formed the research sample. The issues of validity and reliability together with ethical considerations have been looked at. The research design and methodology have laid the foundation for the empirical studies, data collection, analysis, interpretation and conclusion in the following chapters. The next chapter focuses on data analysis, presentation and discussion.

CHAPTER 4

DATA PRESENTATION AND ANALYSIS

4.1 INTRODUCTION

This chapter centres on the analysis and presentation of the data that were collected for the study. Data analysis is presented on learners' and educators' perceptions of cell phones with internet services in the teaching and learning of Physical Sciences. The instruments used for data collection were questionnaires and interview schedules. The researcher analysed these sources to establish the similarities and differences in educators' and learners' views, experiences, attitudes and beliefs. This helped the investigator to come up with a balanced picture of the learners' and educators' perceptions of cell-phone use in the learning and teaching of Physical Sciences.

The following sub-questions of the research question were addressed.

- ❖ What benefits do learners perceive in the use of cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ What benefits do educators perceive in the use of cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ What drawbacks do learners perceive in the use of cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ What drawbacks do educators perceive in the use of cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ Do learners want to continue using cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ Do educators want to continue using cell phones with internet services in the teaching and learning of Physical Sciences?

4.2 PRESENTATION OF DATA

The findings of the study are organized into and presented in two main sections. The first section describes the pilot sample and its purpose, findings and conclusion. The

second section focuses on the main study. The first part of both the pilot study and the main study look at the demographic description of the participants. This is followed by a description of the research methodology and analysis of the study. The process by which data were gathered, collected, recorded and summarized is highlighted. At the end the chapter presents a summary of the results and how the findings relate to the study and specifically address the research questions. In addition the main study tries to assess and evaluate the patterns, relationships and themes emerging from the data.

Tables, graphs and descriptive and inferential statistics are used to present the findings. The learners' and educators' views, attitudes and beliefs regarding the use of cell phones with internet services in science learning and teaching are analysed. Direct quotes from the questionnaires, learner focus groups and educator interviews are used as evidence. The data-analysis methods used are coding, factor analysis, cluster analysis, thematic analysis and methodical triangulation (Fraenkel & Wallen, 2006; Ngulube, 2013). Thematic analysis provides the basis for the learners' and educators' preferences for using cell phones with internet services in the learning and teaching of Physical Sciences.

4.3 OUTLINE OF THE PILOT STUDY

The main purpose of the pilot study was to try out the research methodology and instruments before undertaking the main study (Creswell, 2012). In the pilot study, 30 learners from Grades 10 to 12 and two Physical Sciences educators were used to test the suitability and effectiveness of the research approach, criteria and instruments prior to their inclusion in the main study. The pilot study guided the main study.

4.3.1 Ethical procedures for the pilot study

The pilot research study process included explanations of the study's purpose, instructions, and assurances of confidentiality and anonymity. The respondents were assured that the research was for academic purposes only and findings would be used only in academic publications. All the participants signed the informed consent letter

(see Appendices III, IV, V, VI and VII). Table 4.1 provides an overview of the pilot study.

Table 4.1: Pilot study

		Instruments
Participants	Sample of convenience consisting of 30 learners and two educators	Questionnaire Learner focus-group interview schedule Educator face-to-face interview schedule
Data collection	Printed questionnaire and interview schedules completed under supervision of researcher	
Data analysis	Quantitative and qualitative elementary analysis	
Purpose	Preliminary assessment and evaluation of the feasibility of the research and research instruments	

Table 4.1 mirrors the main features of the pilot study with regard to its purpose. The number of participants was small but big enough to give guidelines and indicators on possible adjustments. The questionnaire was completed the same day under the supervision of the researcher and results were examined. After three days interviews were carried out to triangulate the questionnaire.

4.3.2 Pilot study findings and discussion

The questionnaire gathered mainly quantitative data using demographics, closed items, open-ended questions and items on a 5-point Likert scale, while the interviews collected mainly qualitative data through interviewing learners and educators.

4.3.2.1 Quantitative and qualitative findings of the pilot study

Table 4.2 Summary of findings of the pilot study

		Perceptions
Educators	Combined mean of open-ended items and Likert scale ratings	3.8
Learners	Combined mean of open-ended and Likert scale ratings	4.2
Average		4.0

To enable usage and preference analysis, the closed-form items were coded in such a way that positive perceptions always gave high values while negative perceptions gave low values. For example, the view “I enjoy studying Physical Sciences using cell phones with internet services” was coded from 5 (strongly agree) to 1 (strongly disagree). Then, to establish learners’ and educators’ views about each scale used, the researcher calculated the mean values of their responses to the scales. The researcher considered an average score of >3 as positive, a mean score of 3 as holding a neutral view, and <3 as holding negative opinions. Thus a higher-than-average view score meant that the view was strongly held by the learner or educator (Jin, Feng, Liu & Dai, 2010). Table 4.2 shows that the educators had a mean of 3.8 and the learners one of 4.2. This shows that both the educators and the learners had strongly positive perceptions of the use of cell phones with internet services in the learning and teaching of Physical Sciences. Their average mean score was higher than 3, which made it statistically significant (Jin *et al.*, 2010). Figure 4.1 depicts the mean ratings assigned by educators and learners. Validity was limited because of the smallness of the sample.

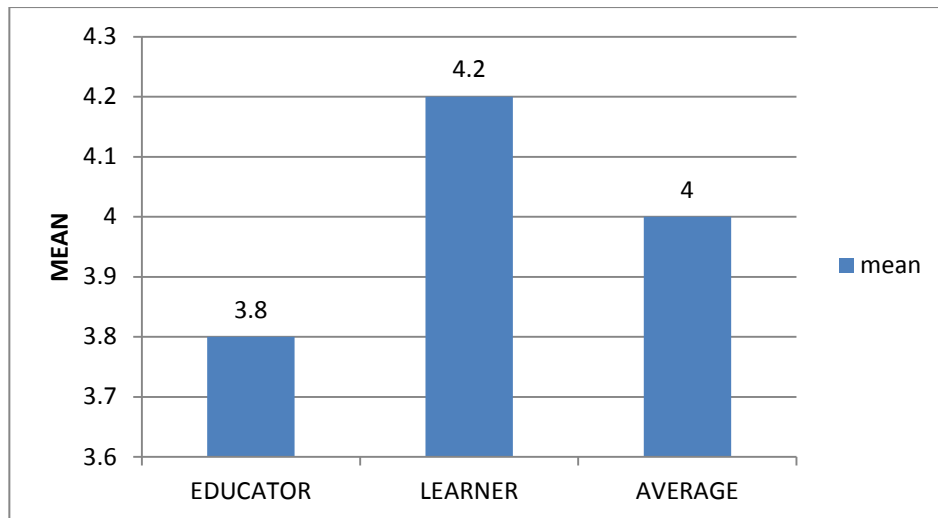


Figure 4.1: Mean perceptions

4.3.3 Quantitative findings from qualitative data

Figure 4.2 shows the qualitative data collected thematically by clustering responses of educators and learners according to their comparable views so that their perceptions of cell-phone use in the teaching and learning of Physical Sciences are shown (Ngulube, 2013). Both of the two educators (100%) and 29 of the learners (97%) reflected positive inclinations towards cell-phone use in Physical Sciences teaching and learning (see figure 4.2).

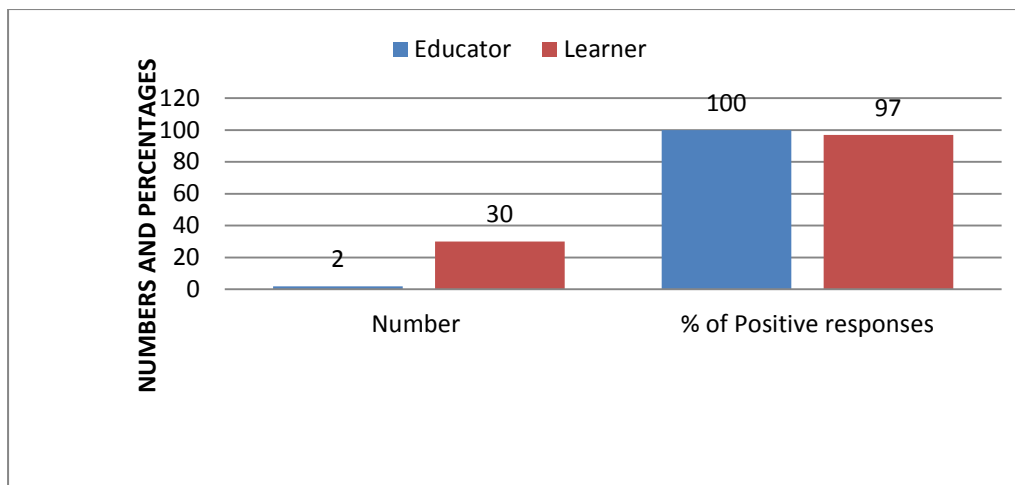


Figure 4.2: Numbers and percentages of combined mean of educators and learners

4.3.4 Conclusion from the pilot study

The findings of the pilot study suggested that there was no problem with the procedures of the planned research study. The views of both the educators and the learners reflected positive perceptions of cell-phone use in the teaching and learning of Physical Sciences. The findings of the pilot study provided data which facilitated purposive sampling in the main study. In the pilot study both the educators and the learners completed similar questions. The pilot study revealed typographical errors in both the interview schedules and the questionnaires, which were immediately corrected. In addition some few minor adjustments, such as changes in font and style, were made on the final instruments. The adjusted and final instruments are appended as Appendices X to XIII.

4.4 Main study summary table

In the following discussion, the learners' and educators' responses to both closed and open-ended questions are analysed and interpreted. There were 340 learners and nine educators who completed the survey.

4.4.1 Analysis of learners' responses to closed-form questionnaire

4.4.1.1 Factor analysis results

Table 4.3: KMO and Bartlett's test

Kaiser-Meyer-Olkin measure of sampling adequacy		0.791
Bartlett's test of sphericity	Approx. Chi-Square	1500.917
	Df	153
	Sig.	0.000

For the factor analysis to be valid and reliable, the KMO should be greater than or equal to 0.7 and Bartlett's test should be less than 0.05 (Brauer, n.d.). As table 4.3 shows, the KMO is 0.791, which is greater than 0.7 and the Bartlett's test is 0.00, which is less than 0.05. Therefore the factor analysis was valid and reliable.

Table 4.4: Communalities

	Initial	Extraction
Q1) I have a good knowledge of the use of a cell phone with internet services.	1.000	0.593
Q2) I enjoy studying Physical Sciences using a cell phone with internet services.	1.000	0.500
Q3) Cell phones with internet services are fun, interesting and convenient in Physical Sciences learning.	1.000	0.572
Q4) Cell phones with internet services help me to study Physical Sciences at and in my own pace and time.	1.000	0.448
Q5) I use my cell phone with internet services to read Physical Sciences before I get to class.	1.000	0.318
Q6) I communicate Physical Sciences ideas with my friends using my cell phone.	1.000	0.491
Q7) A cell phone with internet services helps me to understand Physical Sciences ideas better.	1.000	0.442
Q8) Cell phones with internet services can help to improve Physical Sciences performance.	1.000	0.269
Q9) Cell phones with internet services improve communication between a learner and the educator.	1.000	0.347
Q10) Cell phones with internet services are a quicker method of getting feedback in Physical Sciences.	1.000	0.427
Q11) I do many Physical Sciences exercises through my cell phone with internet services.	1.000	0.521
Q12) SMSs received from my teacher help me to study Physical Sciences better.	1.000	0.516
Q13) I sometimes use a cell phone with internet services in class for things not related to learning.	1.000	0.364

Q14) Cell phones with internet services cannot be used in Physical Sciences learning due to expenses involved.	1.000	0.755
Q15) Cell phones with internet services cannot be used due to poor network in the villages.	1.000	0.743
Q16) Cell phones with internet services cannot be used because they take teachers' jobs.	1.000	0.768
Q17) Most people who are important to me think that a cell phone with internet services improves my Physical Sciences performance.	1.000	0.672
Q18) I enjoy participating in mobile Physical Sciences competitions.	1.000	0.483

Extraction method: principal component analysis

Table 4.4 shows the results of the extracted communalities of the 18 items. It illustrates the proportion of the variance of the items given in the table explained by a common factor. In principal component analysis, the higher the decimal fraction or the percentage of the extraction, the less the importance of the factor (Brauer, n.d.). The learners rated the proposition that cell phones with internet services can help to improve Physical Sciences performance with 0.269, which is approximately 27% , followed by the statement that “I use my cell phone with internet services to read Physical Sciences before I get to class” with a score of 0.318, which is approximately 32%.

The proposition that cell phones with internet services improve communication between a learner and the educator was awarded 0.347, which is approximately 35%, and the statement that “I sometimes use the cell phone with internet services in class for things not related to learning” received a variance of 0.364, which is approximately 36%. These low decimal fractions show that learners put greater importance on the benefits derived from cell-phone use in the teaching and learning of Physical Sciences (Brauer, n.d.). The proposition that cell-phone learning with internet services cannot be used because it takes away teachers' jobs had little significance to participants as it had a variance of 0.768, which is approximately 77%, and the statement that “Most people who are important to me think that using a cell

phone with internet services improves my Physical Sciences performance” had a variance of 0.672, which is approximately 67%. Learners also placed little significance on outside influence, as shown by the high percentages (Brauer, n.d.).

Table 4.5: Principal component analysis

Component	Initial eigenvalues			Rotation sums of squared loadings		
	Total	Percentage of variance	Cumulative percentage	Total	Percentage of variance	Cumulative percentage
1	3.835	21.304	21.304	2.704	15.020	15.020
2	2.624	14.575	35.879	2.618	14.543	29.563
3	1.573	8.738	44.617	2.617	14.536	44.099
4	1.197	6.651	51.269	1.291	7.170	51.269
5	.984	5.468	56.737			
6	.947	5.260	61.997			
7	.836	4.642	66.639			
8	.809	4.492	71.131			
9	.732	4.066	75.197			
10	.704	3.913	79.110			
11	.626	3.477	82.587			
12	.588	3.266	85.853			
13	.555	3.085	88.938			
14	.505	2.806	91.744			
15	.484	2.690	94.434			
16	.440	2.443	96.877			
17	.303	1.681	98.558			
18	.260	1.442	100.000			

Extraction method: principal component analysis

Table 4.5 shows that 18 items of the questionnaire could be represented by four components. Component 1 had an eigenvalue of 2.704 and accounted for 15.020% of the variance. Component 2 had an eigenvalue of 2.618 and accounted for 14.543% of the variance. Component 3 had an eigenvalue of 2.617 and accounted for 14.536% of the variance. Component 4 had an eigenvalue of 1.291 and accounted for 7.170% of the variance (see table 4.5).

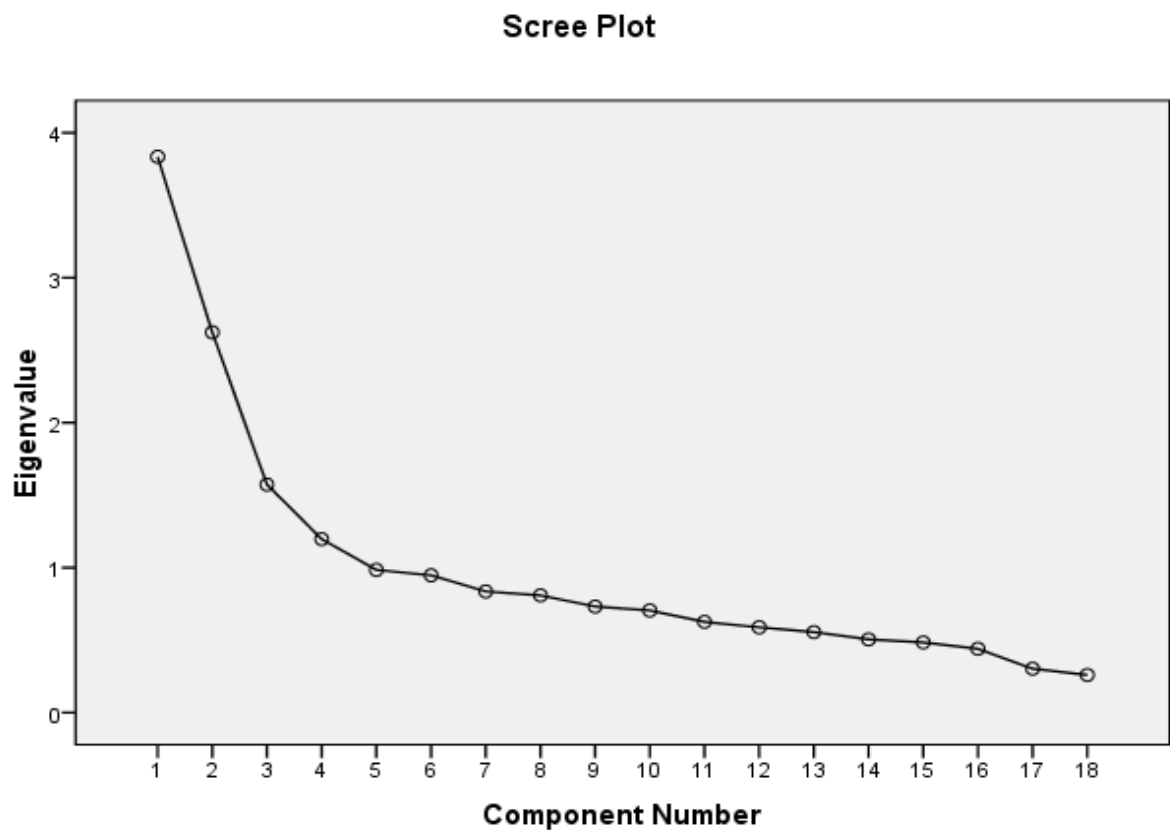


Figure 4.3: Scree plot showing number of components and eigenvalues of the correlation matrix

The researcher used the scree plot to determine the number of factors that could be extracted from the 18 items. SPSS version 19 was used to draw a scree plot to show the number of factors that were representative enough of the 18 items loaded (see figure 4.3). Figure 4.3 of the scree plot reflects the eigenvalues gradually levelling off on the 4th factor, indicating that the 18 items could be classified into four factors. The four factors extracted using these data had eigenvalues greater than 1.2 and they accounted for 51.27% of the cumulative variance (see table 4.5). This was also

confirmed by the rotated component matrix presented by factor analysis (see table 4.6).

Table 4.6: Rotated component matrix

	Component			
	1	2	3	4
Q12) SMSs received from my teacher help me to study Physical Sciences better.	0.706			
Q11) I do many Physical Sciences exercises through my cell phone with internet services.	0.696			
Q6) I communicate Physical Sciences ideas with my friends using my cell phone.	0.645			
Q10) Cell phones with internet services are a quicker method of getting feedback in Physical Sciences.	0.591			
Q9) Cell phones with internet services improve communication between a learner and the educator.	0.582			
Q5) I use my cell phone with internet services to read Physical Sciences before I get to class.	0.493			
Q1) I have a good knowledge of the use of a cell phone with internet services.		0.765		
Q3) Cell phones with internet services are fun, interesting and convenient in Physical Sciences learning.		0.736		

Q2) I enjoy studying Physical Sciences using a cell phone.		0.675		
Q7) A cell phone with internet services helps me to understand Physical Sciences ideas better.		0.603		
Q4) Cell phones with internet services help me to study Physical Sciences at and in my own pace and time.	0.388	0.528		
Q8) Cell phones with internet services can help to improve Physical Sciences performance.		0.437		
14) Cell phones with internet services cannot be used in Physical Sciences learning due to expenses involved.			0.867	
Q16) Cell-phone learning cannot be used because it takes teachers' jobs.			0.862	
Q15) Cell phones with internet services cannot be used due to poor network in the villages.			0.844	
Q13) I sometimes use a cell phone with internet services in class for things not related to learning.			0.576	
Q17) Most people who are important to me think that a cell phone with internet services improves my Physical Sciences performance.				0.809
Q18) I enjoy participating in mobile Physical Sciences competitions.				0.644

Extraction method: principal component analysis

Rotation method: Varimax with Kaiser normalization

Rotation converged in five iterations

The researcher analysed data on 18 items of the questionnaire using orthogonal rotation (Varimax with Kaiser normalization) in order to determine factors which were independent of one another. In addition the researcher analysed the questionnaire instrument using principal component analysis to determine and identify a small number of factors which could be used to give a representation of the relationships amongst the 18 items of the questionnaire. The researcher commenced with 18 items which were fed into the SPSS system and were reduced to four factors. The researcher had to consider only loadings above 0.3 as important (Hair, Anderson, Tatham & Black, 1998; Brauer, n.d). Table 4.6 shows the factor loadings of the 18 items.

The first factor analysis computed four factors that together explained 51% of the variance in the material. Factor 1's theme was perceived benefits or advantages and it was loaded very strongly by seven questions: numbers 4, 5, 6, 9, 10, 11 and 12. These questions' loading coefficients were 0.388, 0.493, 0.645, 0.582, 0.591, 0.696 and 0.706 respectively. Question 4 also loaded most strongly under factor 2. The difference between the cross-loadings was 0.14.

According to Hair *et al.*, (1998), the difference between the loading coefficients should be at least 0.1 in order for there to be valid discrimination between them. The researcher had to include it under both factor 1 and factor 2 since the difference was greater than 0.1. Factor 2's theme was perceived appreciation, attitudes and beliefs. Five questions loaded strongly onto factor 2, namely questions 1, 2, 3, 4, 7 and 8. Their loading coefficients were 0.765, 0.675, 0.736, 0.528, 0.603 and 0.437 respectively. Factor 3 measured the perceived disadvantages and it was loaded strongly on by four questions, numbers 13, 14, 15 and 16. Their loading coefficients were 0.576, 0.867, 0.844 and 0.862 respectively. Factor 4's theme was perceived influence from outside and it was loaded on heavily by two questions, numbers 17 and 18. Their loading coefficients were 0.809 and 0.644 respectively.

The questionnaire consisted of 18 items made up of closed-form items put on a 5-point Likert scale offering *strongly agree*; *agree*; *undecided*; *disagree* and *strongly disagree* (see Appendix IX).

Table 4.7 provides an overview of the frequencies and percentages of learners' statistics on the use of cell phones with internet services in the teaching and learning of Physical Sciences. Responses to each of the indicators on cell-phone use in the teaching and learning of Physical Sciences were shown measured on a Likert scale of 1 to 5 ranging from "strongly agree" to "strongly disagree". In this research study a score above 3.0 was taken to indicate relative importance, a score of 3 was taken to reflect neither importance nor unimportance, and a score below 3 was taken to show relative unimportance.

A total of 230 out of 338 learners (68%) strongly agreed on item 10; 224 learners (66.3%) strongly agreed on item 1; 197 learners (58.3%) strongly agreed on item 4; 186 learners (53%) strongly agreed on item 2; 184 learners (54.4%) strongly agreed on item 8; 173 learners (51.2%) strongly agreed on item 7; 161 learners (47.6%) strongly agreed on item 3; 142 learners (42%) strongly agreed on item 6; 131 learners (38.8%) strongly agreed on item 11; 126 learners (37.3%) strongly agreed on item 9; 107 learners (31.7) strongly agreed on item 12; and 101 learners (29.9%) strongly agreed on item 5. In general these high percentages of 30 and above ($30 \leq$) show that most of the learners held strong positive attitudes and beliefs regarding the use of cell phones with internet services in the teaching and learning of Physical Sciences.

However, out of a total of 338, only one learner (0.3%) strongly disagreed on item 10; one learner (0.3%) strongly disagreed on item 8; two learners (0.6%) strongly disagreed on item 4; two learners (0.6%) strongly disagreed on item 2; two learners (0.6%) strongly disagreed on item 7; two learners (0.6%) strongly disagreed on item 9; three learners (0.9%) strongly disagreed on item 3; four learners (1.2%) strongly disagreed on item 1; five learners (1.5%) strongly disagreed on item 11; eight learners (2.4%) strongly disagreed on item 6; 13 learners (3.8%) strongly disagreed on item 5; and 24 learners (7.1%) strongly disagreed on item 12. These low percentages show that very few learners had negative beliefs and attitudes towards the use of cell phones with internet services in the teaching and learning of Physical Sciences.

There was an average score of 5.54% learners who remained undecided about their beliefs and attitudes. This probably shows either that these learners were not convinced of the benefits of cell phones with internet services and needed time to consider or that they just did not want to open up. Responding to items on the disadvantages of cell-phone use, 27 learners (8.0%) strongly agreed on item 13; 38 learners (11.2%) strongly agreed on item 14; and 38 learners (11.2%) strongly agreed on item 16. These low percentages indicate that learners see the disadvantages as not outweighing the advantages.

Furthermore, 224 learners (66.3%) did not agree strongly with the proposition that cell phones cannot be used because they would take away the teacher's job. This shows that learners still think educators have a role to play in their learning. Forty-eight learners (14.2%) strongly agreed with item 15, which said that poor networks in the villages can hamper implementation of cell-phone use in the learning and teaching of Physical Sciences, while 85.8% did not. Paul (1995) and Prensky (2010) point out similar disadvantages of cell phones.

The findings of this study show that most of the learners did not agree that the disadvantages of cell phones hampered their use in the classroom. These learners wanted to continue with their use of cell phones in the learning of Physical Sciences.

**Table 4.7: Descriptive statistics (learners): frequency and percentages
(percentages in brackets)**

	Questionnaire item	Strongly agree [5]	Agree [4]	Undecided [3]	Disagree [2]	Strongly disagree [1]	No
1	I have a good knowledge of the use of a cell phone with internet services.	224 (66.3)	102 (30.2)	5 (1.5)	3 (0.9)	4 (1.2)	338
2	I enjoy studying Physical Sciences using a cell phone with internet services.	186 (55)	136 (40.2)	9 (2.7)	5 (1.5)	2 (0.6)	338

3	Cell phones with internet services are fun, interesting and convenient in Physical Sciences learning.	161 (47.6)	159 (47)	10 (3)	5 (1.5)	3 (0.9)	338
4	Cell phones with internet services help me to study Physical Sciences at and in my own pace and time.	197 (58.3)	120 (35.5)	15 (4.4)	4 (1.2)	2 (0.6)	338
5	I use my cell phone with internet services to read Physical Sciences before I get to class.	101 (29.9)	131 (38.8)	58 (17.2)	35 (10.4)	13 (3.8)	338
6	I communicate Physical Sciences ideas with my friends using my cell phone with internet services.	142 (42)	153 (45.3)	19 (5.6)	16 (4.7)	8 (2.4)	338
7	A cell phone with internet services helps me to understand Physical Sciences ideas better.	173 (51.2)	146 (43.2)	8 (2.4)	9 (2.7)	2 (0.6)	338
8	Cell phones with internet services can help to improve Physical Sciences performance.	184 (54.4)	141 (41.7)	12 (3.6)	0 (0.0)	1 (0.3)	338

9	Cell phones with internet services improve communication between a learner and the educator.	126 (37.3)	176 (52.1)	28 (8.3)	6 (1.8)	2 (0.6)	338
10	Cell phones with internet services are a quicker method of getting feedback in Physical Sciences.	230 (68)	93 (27.5)	11 (3.3)	3 (0.9)	1 (0.3)	338
11	I do many Physical Sciences exercises through my cell phone with internet services.	131 (38.8)	172 (50.9)	19 (5.6)	11 (3.3)	5 (1.5)	338
12	SMSs received from my teacher help me to study Physical Sciences better.	107 (31.7)	163 (48.2)	30 (8.9)	14 (4.1)	24 (7.1)	338
13	I sometimes use a cell phone with internet services in class for things not related to learning.	27 (8.0)	38 (11.2)	38 (11.2)	106 (31.4)	129 (38.2)	338
14	Cell phones with internet services cannot be used in Physical Sciences learning due to expenses involved.	38 (11.2)	60 (17.8)	42 (12.4)	102 (30.2)	96 (28.4)	338
15	Cell-phone learning cannot be used due to poor network in the villages.	48 (14.2)	58 (17.2)	22 (6.5)	107 (31.7)	103 (30.5)	338
16	Cell-phone learning cannot be used because it takes teachers' jobs.	38 (11.2)	47 (13.9)	29 (8.6)	103 (30.5)	121 (35.8)	338

17	Most people who are important to me think that a cell phone with internet services improves my Physical Sciences performance.						
18	I enjoy participating in mobile Physical Sciences competition.						
	Average total frequency and percentages	132(39.07%)	118(35%)	22(6.58%)	33(9.8%)	33(9.55%)	338

Figure 4.4 below shows a bar graph of average total frequency and percentages of learners' responses. *Strongly agree* has the highest average frequency, followed by *agree*, *disagree*, *strongly disagree* and *undecided* in that order.

Strongly agree and *agree* gave a total of 74.07%, while *strongly disagree* and *disagree* added up to 19.35%. The high percentage of learners with positive perceptions tells us that learners enjoy and want to continue using cell phones with internet services in the teaching and learning of Physical Sciences.

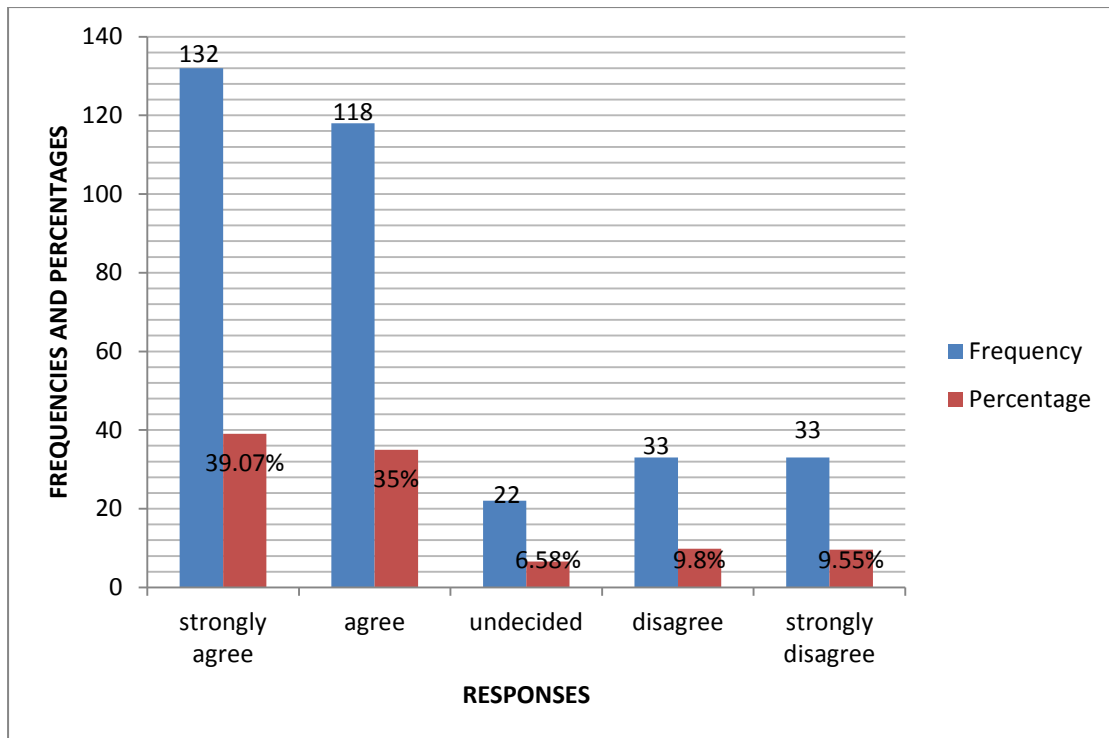


Figure 4.4: Bar graph of average total frequency and percentages of learners' responses

Table 4.8: Item statistics

	Mean	Standard deviation	N
Q1) I have a good knowledge of the use of a cell phone with internet services.	4.59	0.684	338
Q2) I enjoy studying Physical Sciences using a cell phone with internet services.	4.48	0.681	338
Q3) Cell phones with internet services are fun, interesting and convenient in Physical Sciences learning.	4.39	0.703	338
Q4) A cell phone with internet services helps me to study Physical Sciences at and in my own pace and time.	4.50	0.694	338
Q5) I use my cell phone with internet services to read Physical Sciences before I get to class.	3.80	1.094	338
Q6) I communicate Physical Sciences ideas with my friends using my cell phone with internet services.	4.20	0.918	338

Q7) A cell phone with internet services helps me to understand Physical Sciences ideas better.	4.42	0.723	338
Q8) Cell phones with internet services can help to improve Physical Sciences performance.	4.50	0.598	338
Q9) Cell phones with internet services improve communication between a learner and the educator.	4.24	0.725	338
Q10) Cell phones with internet services are a quicker method of getting feedback in Physical Sciences.	4.62	0.625	338
Q11) I do many Physical Sciences exercises through my cell phone with internet services.	4.22	0.812	338
Q12) SMSs received from my teacher help me to study Physical Sciences better.	3.93	1.100	338
Q13) I sometimes use a cell phone with internet services in class for things not related to learning.	2.20	1.276	338
Q14) Cell phones with internet services cannot be used in Physical Sciences learning due to expenses involved.	2.53	1.361	338
Q15) Cell-phone learning cannot be used due to poor network in the villages.	2.53	1.435	338
Q16) Cell-phone learning cannot be used because it takes teachers' jobs.	2.34	1.378	338
Q17) Most people who are important to me think that a cell phone with internet services improves my Physical Sciences performance.	4.10	0.919	338
Q18) I enjoy participating in mobile Physical Sciences competitions.	4.44	0.825	338

The mean scores of Qq. 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 17 and 18 were very high, ranging from 4.10 to 4.59. This shows that learners agreed with the statements on the benefits or the utility of cell phones with internet services in the teaching and learning of Physical Sciences. The mean scores on Q5 (3.80) and Q12 (3.93), which measured usage and communication, were comparably high. However, Qq. 13, 14, 15 and 16

produced low means, indicating that learners did not worry much about them. Qq. 13, 14, 15 and 16 referred to the perceived disadvantages, which learners thought were not strong enough to hinder them from using cell phones. The standard deviations for Qq. 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 17 and 18 were similar, reflecting very little variability. The standard deviation for Q15 was very high (1.435), suggesting more variability for this item, which signifies that the learners were not worried about poor networks. By contrast, Q8 had the lowest standard deviation (0.598), signifying low variability and suggesting that the learners strongly believed that the use of cell phones with internet services would help them to pass Physical Sciences despite the disadvantages they faced.

Table 4.9: Summary item statistics

	Mean	Minimum	Maximum	Range	Maximum / minimum	Variance	Number of items
Item means	3.891	2.195	4.621	2.426	2.105	0.722	18
Item variances	0.921	0.358	2.060	1.702	5.761	0.331	18

A mean of 3.891 and a standard deviation of 0.960 were obtained for the 18 items. The standard deviation was small, showing that there is very little variability and that the learners strongly supported the use of cell phones with internet services in the teaching of Physical Sciences. Their maximum was 4.621 and the minimum was 2.195 with a small range of 2.426 reflecting normal dispersion.

4.4.1.2 Analysis of learners' responses to closed-form questionnaire

Table 4.10: What is your gender?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Female	176	52.1	52.1	52.1
	Male	162	47.9	47.9	100.0
	Total	338	100.0	100.0	

More girls (176, or 52.1%) than boys (162, or 47.9%) participated in the research. The difference between the number of girls and that of boys was 14(4.2%). Figure 4.5 shows the numbers and percentages of the female and male learners.

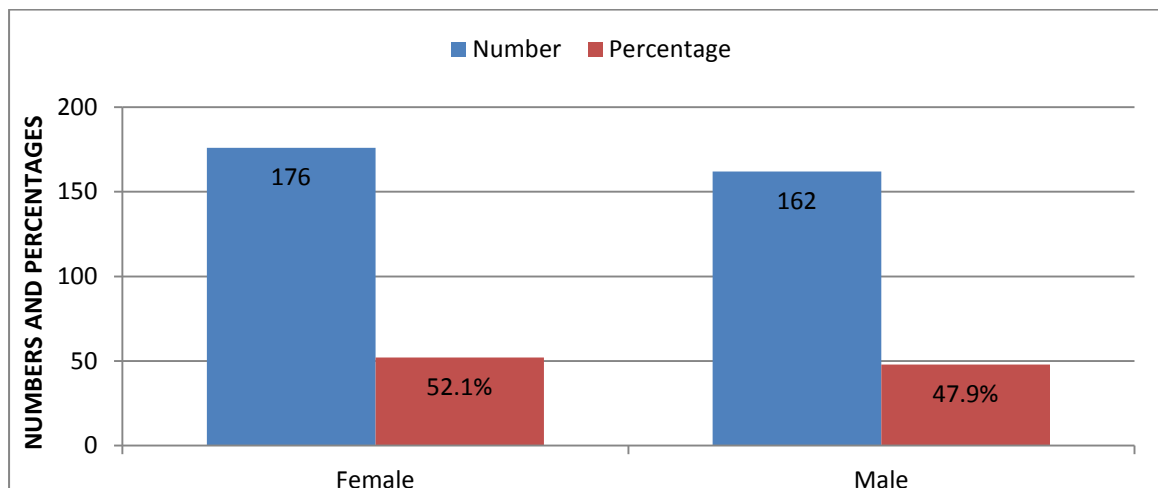


Figure 4.5: Numbers and percentages of learners according to gender

The numbers of girls and of boys who participated were nearly the same. This probably this allowed a balance of views from both genders.

Table 4.11: What is your age?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	15	43	12.7	12.7	12.7
	16	113	33.4	33.4	46.2
	17	81	24.0	24.0	70.1
	18	75	22.2	22.2	92.3
	19	20	5.9	5.9	98.2
	20	3	0.9	0.9	99.1
	21	3	0.9	0.9	100.0
	Total	338	100.0	100.0	

The most common ages were 16 with a total of 113 learners, followed by 17 with a total of 81, 18 with a total of 75, and 15 with a total of 43. These are the common ages found in high schools. As a result, the researcher was satisfied that he was dealing with the relevant age groups. However, the ages of 20 (0.9%) and 21(0.9%) are not common in high schools. Those aged 19 years and above should be out of school and perhaps enrolled at tertiary institutions. Figure 4.6 presents the ages of learners who participated in terms of percentages.

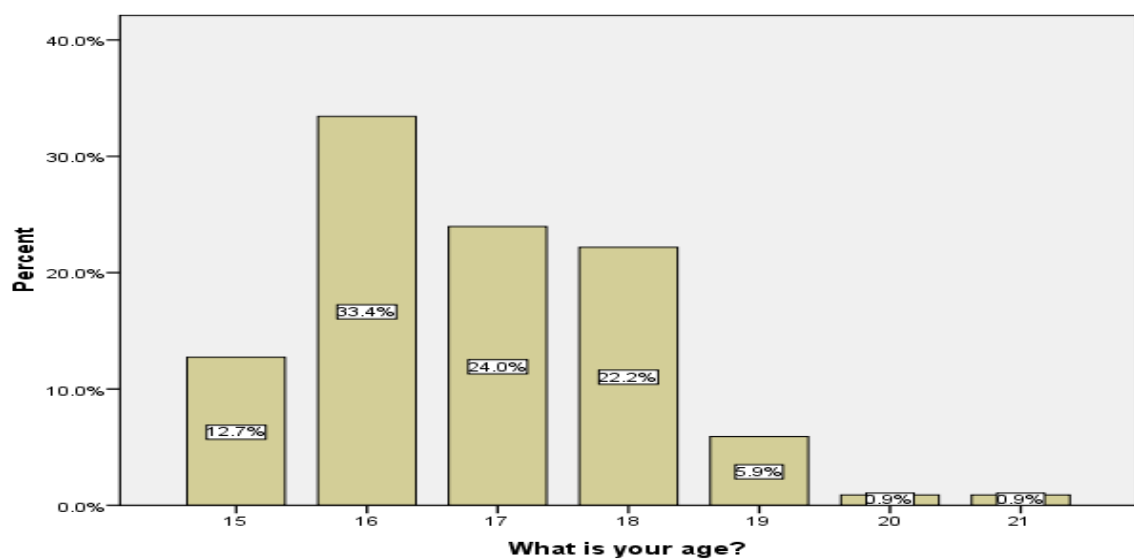


Figure 4.6: Percentage of learners in each age group

Table 4.12: Do you have a cell phone with internet services?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Yes	297	87.9	87.9	87.9
	No	41	12.1	12.1	100.0
	Total	338	100.0	100.0	

Only 12% of the learners did not own a cell phone with internet services, compared with the 88% who had cell phones with internet services. This suggests that 12% of the learners accessed cell phones with internet services through sharing or borrowing (see figure 4.7).

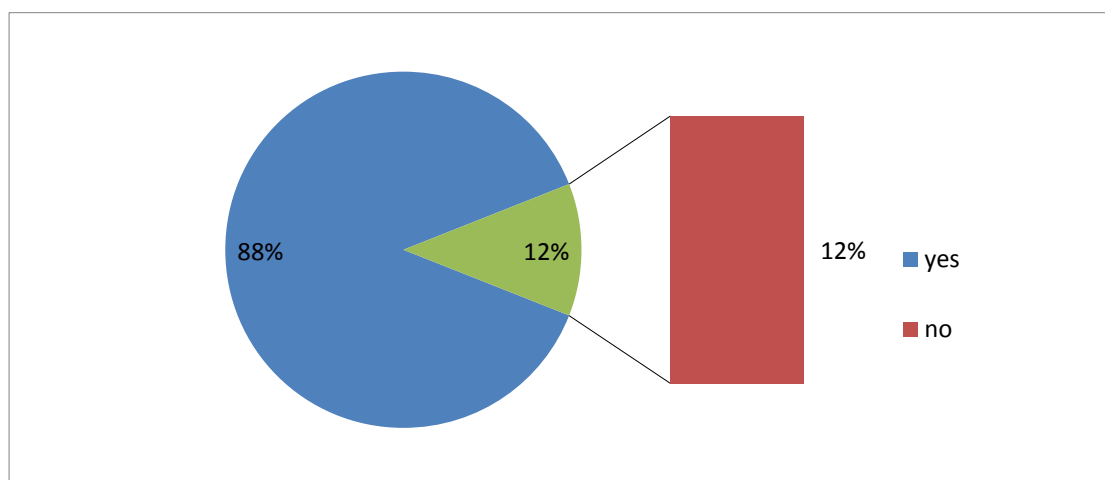


Figure 4.7: Percentage of learners with cell phones with internet services

Table 4.13: Do you use a cell phone for Physical Sciences learning?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Yes	327	96.7	96.7	96.7
	No	11	3.3	3.3	100.0
	Total	338	100.0	100.0	

A total of 327 (96.7%) of the learners agreed that they used cell phones with internet services for the study of Physical Sciences while 11 (3.3%) said they did not use

them. This means that a few learners needed to be motivated to start using their cell phones with internet services for study. Figure 4.8 shows the results on usage.

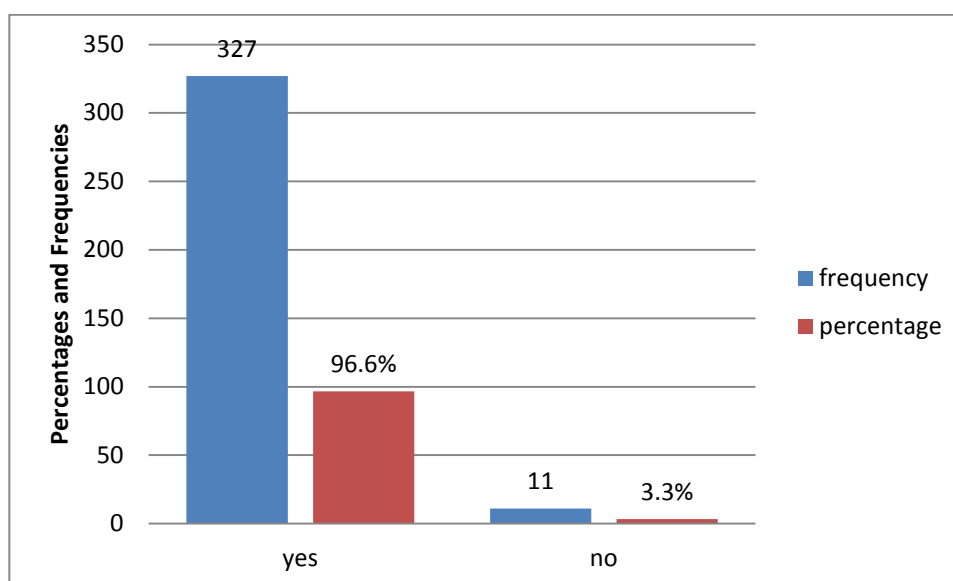


Figure 4.8: Learner frequency and percentages of cell-phone use

In all, the researcher concluded, most learners (327, or 96.7%) found it of benefit to use cell phones with internet services in their study of Physical Sciences.

Table 4.14: If “Yes”, how many times a week do you use a cell phone for Physical Sciences learning?

		Frequency	Percentage	Valid Percentage	Cumulative percentage
Valid	1-2 times	113	33.4	33.4	33.4
	3-4 times	179	53.0	53.0	86.4
	5 or more times	46	13.6	13.6	100.0
	Total	338	100.0	100.0	

179 learners (53.0%) were shown to be frequent users of cell phones and 46 learners (13.6%) to be heavy users. The learners using them least numbered 113 (33.4%). The

results revealed that learners were comfortable with the use of cell phones with internet services in the teaching and learning of Physical Sciences.

Table 4.15: How many times a week do you receive SMS comments from your teacher?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	1-2 times	143	42.3	42.3	42.3
	3-4 times	140	41.4	41.4	83.7
	5 or more times	17	5.0	5.0	88.8
	Not at all	38	11.2	11.2	100.0
	Total	338	100.0	100.0	

There was a relatively high frequency of communication between educator and learner per week (see table 4.15). 88.8% of the learners answered that they used a cell phone for communication at least once a week, while 11.2% of the learners did not communicate using cell phones with their educator. The high percentage of learner communication shows that the learners and educators were positive towards the use of cell phones in teaching and learning (see figure 4.9).

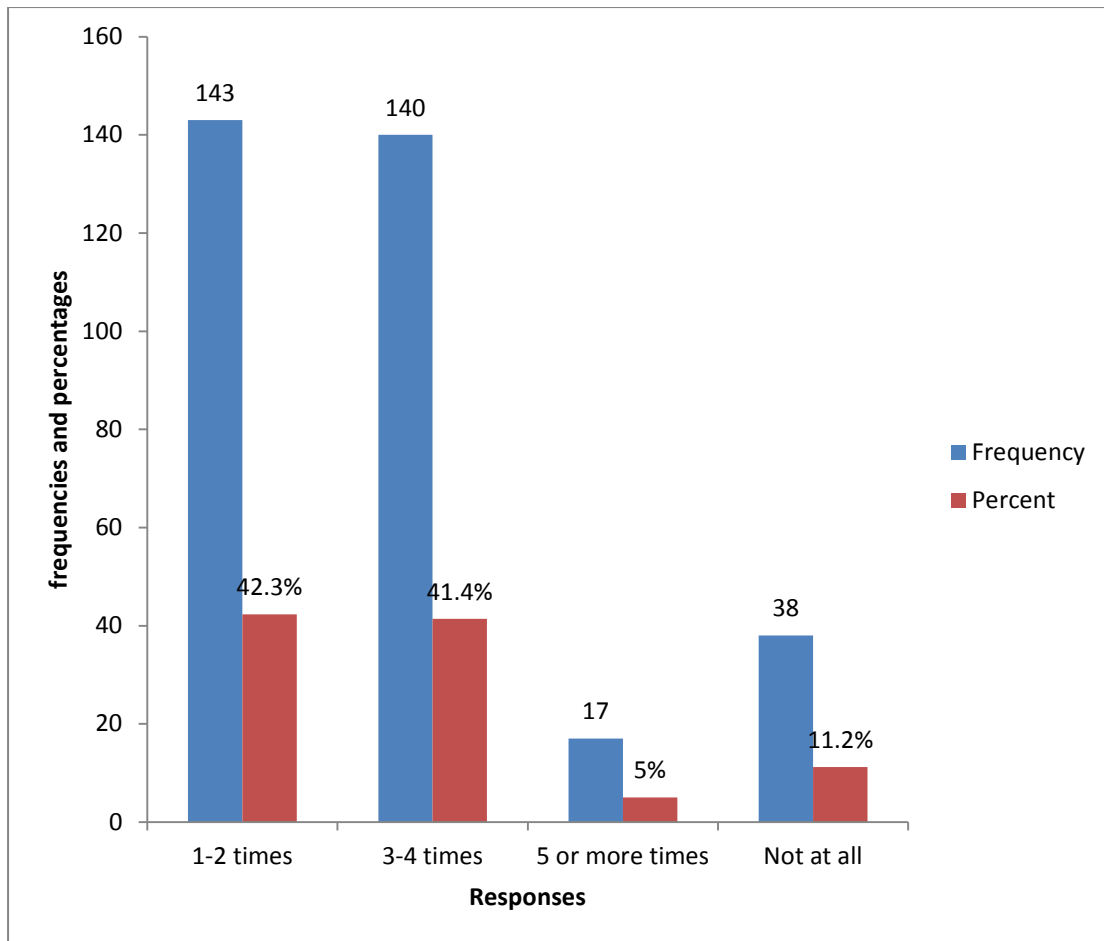


Figure 4.9: Frequencies and percentages of teacher-learner communication per week

The frequency of teacher-learner communication was high, with ratings of 42.3% for between once and twice, 41.4% for three to four times and 5% for five or more times, making a total of 88.8% for positive communication as against 11.2% for no communication.

Table 4.16: Do you think a mobile Physical Sciences programme helps you to pass Physical Sciences?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Yes	299	88.5	88.5	88.5
	No	12	3.6	3.6	92.0
	Not sure	27	8.0	8.0	100.0
	Total	338	100.0	100.0	

A total of 299 learners (88.5%) said that cell phones with internet services helped them improve in Physical Sciences performances. These findings agree with those of Thornton and Houser (2005), whose study in Japan revealed that the students understood better when they used mobile phones than when they worked via paper materials. However, in the present study a total of 12 learners (3.6%) did not agree, while 27(8%) could not decide. Figure 4.10 reflects the results.

There were a small number of learners (4%) who did not agree that cell phones with internet services helped them to pass Physical Sciences. A very high percentage (88%) of learners stated that cell phones with internet services helped them pass Physical Sciences. This indicates that most of the learners were benefiting from the use of cell phones with internet services.

Table 4.17: What I like most about cell phones with internet services in Physical Sciences learning is: (choose one answer only)

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Cell-phone Physical Sciences exercises and experiments are easy to understand.	62	18.3	18.3	18.3

Cell-phone Physical Sciences programmes give quick feedback on exercises and tests.	35	10.4	10.4	28.7
I can compare my performance with that of other learners.	21	6.2	6.2	34.9
Mobile sciences use audio-visual aids.	37	10.9	10.9	45.9
All of the above.	183	54.1	54.1	100.0
Total	338	100.0	100.0	

Most learners (183) showed positive preferences towards the benefits of cell-phone use in Physical Sciences learning and teaching. This confirms Milrad's and Spikol's 2007 study in Sweden and Project Tomorrow's 2010 study in North Carolina, which reflected similar advantages of cell-phone use. Learners were aware of the benefits of cell phones with internet services and liked them.

Table 4.18: Do you think cell phones with internet services should be used for Physical Sciences learning in all schools?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Yes	290	85.8	85.8	85.8
	No	12	3.6	3.6	89.3
	Not sure	36	10.7	10.7	100.0
	Total	338	100.0	100.0	

Most learners (290, or 85.8%) believed that cell phones with internet services should be used in the teaching and learning of Physical Sciences. Twelve learners (3.6%), however, did not support the use of cell phones. These learners could be those who do not own cell phones or who have found them expensive and unnecessary. Thirty-six learners (10.7%) were undecided, perhaps because they were unsure of the benefits

perceived by the majority. Figure 4.10 shows the percentages of the learners' choices.

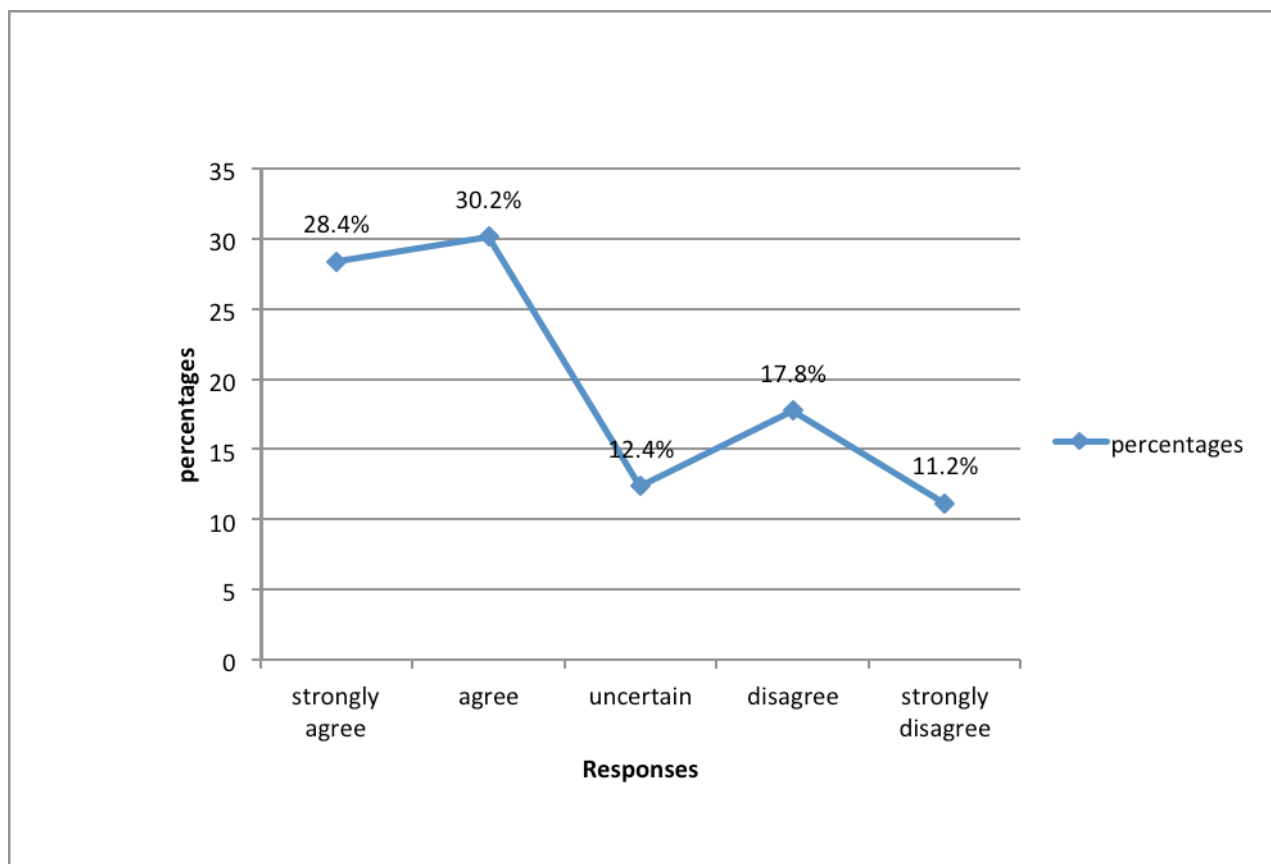


Figure 4.10: Do you think cell phones with internet services should be used for Physical Sciences learning in all schools?

A high percentage of learners (28.4%) strongly agreed and 30.2% agreed, while 17.8% disagreed and a low percentage of 11.2% strongly disagreed on the use of cell phones in the teaching and learning of Physical Sciences. Thus 58.6% of the responses reflect positive feelings on the part of the learners towards the idea that cell phones with internet services should be used in the teaching and learning of Physical Sciences.

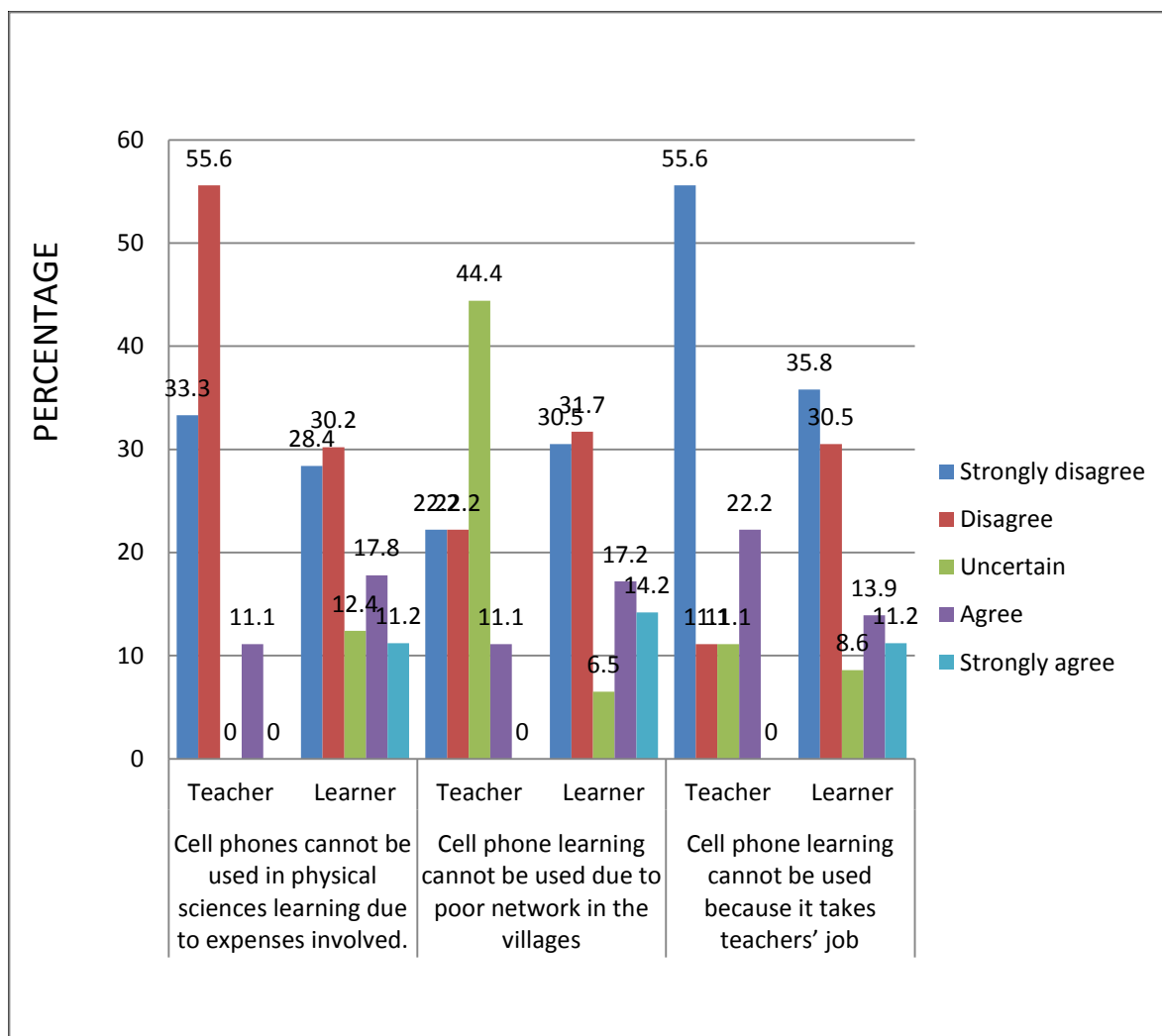


Figure 4.11: Comparison of teachers' and learners' perceptions of disadvantages of cell-phone use in teaching and learning Physical Sciences

A third of the educators (33.3%) strongly disagreed and 55.6% disagreed with the proposition that cell phones with internet services cannot be used in Physical Sciences learning because of the expenses involved. They may have thought this reason not strong enough to bar the implementation of cell-phone use in the teaching and learning of Physical Sciences. Among the learners, 58.6% also believed that cell phones were not ruled out because of the expenses they involved (see figure 4.11). Thus most of the teachers and learners agreed that cell phones with internet services can be used for learning and teaching Physical Sciences despite the expenses involved.

On the proposition that cell phones cannot be used for teaching and learning because of poor networking in the villages, educators scored a total of 44.4% for *strongly disagree* and *disagree*. The equivalent figure among the learners was 62.2%, showing that they felt even more strongly that poor networking in the villages was not a good reason to block the use of cell phones in the teaching and learning of Physical Sciences.

Teachers felt by a combined score of 66.7% that cell phones with internet services could not take their jobs, and learners feeling the same scored 66.7% against the idea of not using cell phones in the learning of Physical Sciences on the basis that they would take away the teachers' jobs (see figure 4.11).

In general, both learners and educators agreed that the disadvantages of cell-phone use in the teaching and learning of Physical Sciences did not outweigh the advantages.

The research reflects a general consensus among all the participants that cell phones with internet services must be used for the teaching and learning of Physical Sciences.

4.4.2 Analysis of educators' closed-form questionnaire responses

4.4.2.1 Factor analysis

Table 4.19: Communalities

	Initial	Extraction
Q1) I have a good knowledge of the use of a cell phone with internet services.	1.000	0.914
Q2) I enjoy reading Physical Sciences using a cell phone with internet services.	1.000	0.751
Q3) Cell phones with internet services are fun, interesting and convenient in Physical Sciences teaching and learning.	1.000	0.845
Q4) Cell phones with internet services help learners to understand Physical Sciences concepts better.	1.000	0.929

Q5) Cell phones with internet services give learners the opportunity to study Physical Sciences at their own pace anywhere and at any time.	1.000	0.877
Q6) I always communicate with my learners doing Physical Sciences with my cell phone with internet services.	1.000	0.930
Q7) Mobile Physical Sciences is an effective and efficient method of learning physical sciences.	1.000	0.942
Q8) Cell phones with internet services can improve Physical Sciences performance.	1.000	0.870
Q9) Cell-phone programmes give me more time to help my Physical Sciences learners.	1.000	0.916
Q10) A cell phone with internet services is a quicker method of getting feedback in Physical Sciences.	1.000	0.961
Q11) Learners do many Physical Sciences exercises because cell-phone use is interesting to them.	1.000	0.969
Q12) Cell phones with internet services improve communication between a learner and the educator.	1.000	0.806
Q13) Cell phones with internet services cannot be used due to unavailability of cell phones to learners.	1.000	0.877
Q14) Cell phones with internet services cannot be used due to expenses involved in mobile learning.	1.000	0.827
Q15) Cell phones with internet services cannot be used due to poor network in the villages.	1.000	0.889
Q16) Cell phones with internet services cannot be used due to abuse by learners in the schools.	1.000	0.861
Q17) Cell phones with internet services cannot be used because they take teachers' jobs.	1.000	0.872
Q18) I enjoy participating in Physical Sciences cell-phone learning and teaching.	1.000	0.808

Extraction method: principal component analysis

The educators placed great significance on item Q2, which carried a weighting of 0.751 (75%). Item Q12 followed as the second in importance with a weighting of 0.806 (81%), item Q18 with a weighting of 0.808 (81%) came third, and item Q14 with a weighting of 0.827 (83%) ranked fourth in importance, while item Q3 with a weighting of 0.845 (85%) and item Q16 with a weighting of 0.861 (86%) were fifth and sixth respectively. The central theme of items Qq. 2, 3, 12 and 18 was the perceived enjoyment and benefits of using cell phones with internet services in the teaching and learning of Physical Sciences. The low percentages of Q14 with a weighting of 0.827 (82.7%), Q15 with 0.889 (88.9%), Q16 with 0.861 (86.1%) and Q17 with 0.872 (87.2%) indicate that the educators consider the perceived disadvantages of cell phones to be strongly affecting their use in the teaching and learning of Physical Sciences. This contrasts with the views of the learners, who regarded the perceived disadvantages as unimportant to their use of cell phones with internet services.

However, there were some items which were regarded by the educators as of little significance. These had high scores: for example, item Q11 with a weighting of 0.969 (97%) was the least, followed by item Q10 with a weighting of 0.961 (96%), item Q7 with a weighting of 0.942 (94%) and item Q6 with a weighting of 0.930 (93%). Items Qq. 11, 10, 7 and 6 concerned perceived benefits of cell phones, which seemingly the educators did not regard as important. This was in contrast to the learners, who regarded the perceived benefits as of great importance.

Table 4.20: Total variance explained

Component	Initial eigenvalues			Rotation sums of squared loadings		
	Total	Percentage of variance	Cumulative percentage	Total	Percentage of variance	Cumulative percentage
1	6.883	38.240	38.240	6.234	34.634	34.634
2	5.055	28.083	66.323	4.170	23.168	57.802
3	2.443	13.571	79.895	3.117	17.318	75.120
4	1.463	8.130	88.025	2.323	12.905	88.025
5	0.867	4.819	92.844			

6	0.744	4.131	96.974			
7	0.409	2.274	99.249			
8	0.135	0.751	100.000			
9	5.698E-16	3.165E-15	100.000			
10	3.025E-16	1.681E-15	100.000			
11	9.973E-17	5.541E-16	100.000			
12	-8.551E-18	-4.751E-17	100.000			
13	-7.780E-17	-4.322E-16	100.000			
14	-1.093E-16	-6.072E-16	100.000			
15	-1.505E-16	-8.359E-16	100.000			
16	-2.114E-16	-1.174E-15	100.000			
17	-3.186E-16	-1.770E-15	100.000			
18	-3.422E-16	-1.901E-15	100.000			

Extraction method: principal component analysis

Principal component analysis reduced the 18 items to four components regarded as important. Component 1 had an eigenvalue of 6.234 and accounted for 34.634% of the variance. Component 2 had an eigenvalue of 4.170 and accounted for 57.802% of the variance. Component 3 had an eigenvalue of 3.117 and accounted for 75.120% of the variance. Component 4 had an eigenvalue of 2.323 and accounted for 88.025% of the variance (see table 4.20). These variances reflect how closely they measure the same factor. Component 1 shows the smallest variance, which indicates that the items are closest to identical, while component 4 with the biggest variance shows that the items are widely spread out and less related.

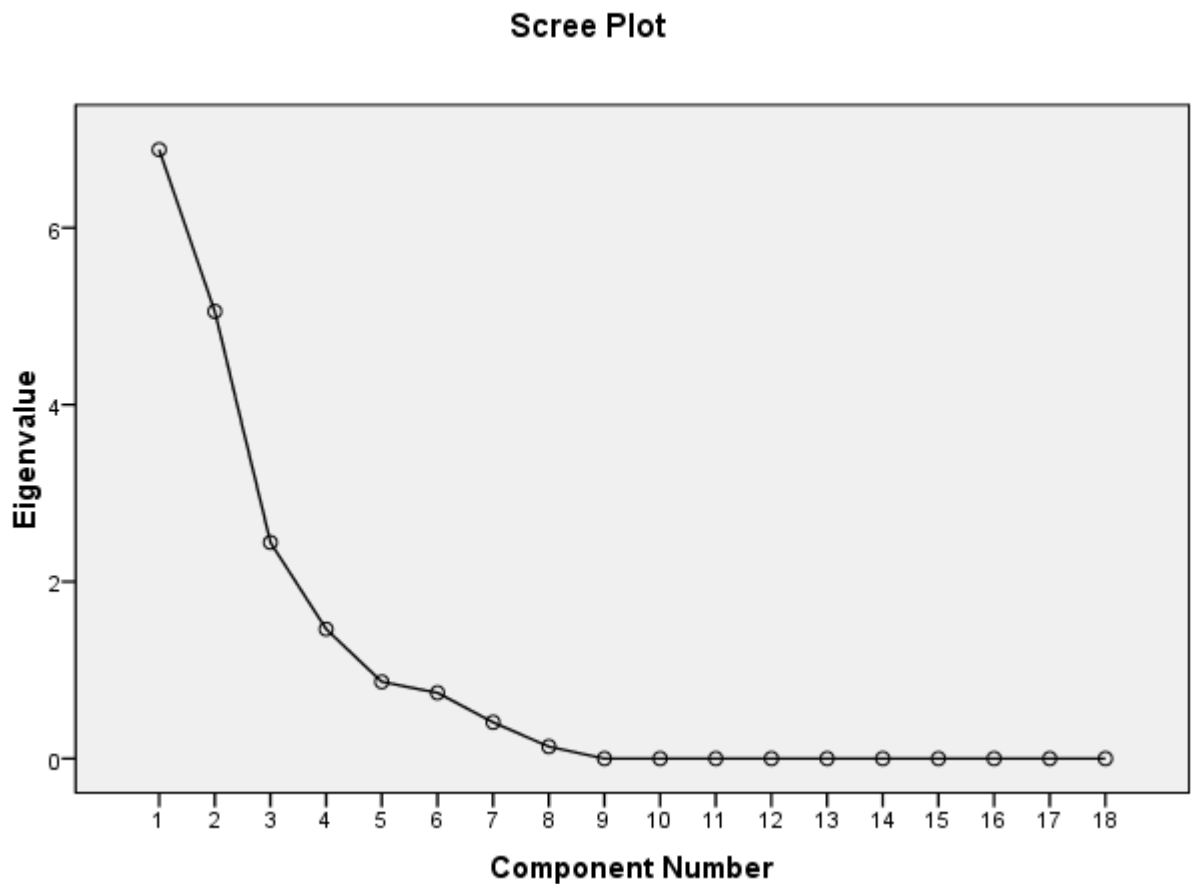


Figure 4.12: Scree plot showing number of components and eigenvalues of correlation matrix

The researcher used the scree plot to determine the number of factors that could be extracted from the 18 items. SPSS version 19 was the software used to come up with the scree plot shown in figure 4.12. The researcher loaded 18 items into SPSS version 19 software and the results are shown in figure 4.12. Figure 4.12 of the scree plot shows the eigenvalues gradually levelling off on the fourth factor, signifying that the 18 items could be classified into four factors. The four factors extracted using these data have eigenvalues greater than 1.5 and they account for 88.03% of cumulative variance (see table 4.20). This was further confirmed by the rotated component matrix presented by factor analysis (see table 4.21).

Table 4.21: Rotated component matrix

	Component			
	1	2	3	4
Q1) Cell-phone programmes give me more time to help my Physical Sciences learners.	.952			
Q2) I always communicate with my learners doing Physical Sciences with my cell phone with internet services.	.896	-.327		
Q3) Cell-phone programmes give learners the opportunity to study Physical Sciences at their own pace anywhere and at any time.	.867		-.341	
Q4) I enjoy reading Physical Sciences using a cell phone with internet services.	.848			
Q5) Cell phones with internet services improve communication between a learner and the educator.	.782	.316		
Q6) I enjoy participating in Physical Sciences cell-phone learning and teaching.	.772		.303	
Q7) I have a good knowledge of the use of a cell phone with internet services.	.692	.431	.493	
Q8) Cell phones with internet services are fun, interesting and convenient in Physical Sciences teaching and learning.	.666		.431	.392
Q9) Learners do many Physical Sciences exercises because cell-phone use is interesting to them.	.658	.466		.545
Q10) Cell phones with internet services cannot be used due to unavailability of cell phones to learners.		-.919		
Q11) Cell phones with internet services can improve Physical Sciences performance.		.842		.313
Q12) Cell phones with internet services cannot be used due to expenses involved in mobile learning.	.361	-.768	-.322	

Q13) Cell phones with internet services are effective and efficient in the teaching and learning of Physical Sciences.	.439	.704		.502
Q14) Cell phones with internet services cannot be used due to abuse by learners in the schools.		-.657	.615	
Q15) Cell phones with internet services cannot be used due to poor network in the villages.			.929	
Q16) A cell phone with internet services is a quicker method of getting feedback in Physical Sciences.		.424	.756	.401
Q17) Cell phones with internet services help learners to understand Physical Sciences concepts better.		.368	.612	.595
Q18) Cell phones with internet services cannot be used because they take teachers' jobs.				-.920

Extraction method: principal component analysis

Rotation method: Varimax with Kaiser normalization

Rotation converged in seven iterations

In this study the researcher analysed data on 18 items of the educators' questionnaire using orthogonal rotation (Varimax with Kaiser normalization) so that he could determine factors which were independent of one another. The researcher began with 18 items which were loaded into the SPSS version 19 system and were summarized to four factors. The researcher had to consider only loadings above 0.3 as important. Table 4.21 shows the factor loadings of the 18 items.

The first factor analysis computed four factors that together explained 88.03% of the variance in the material. Eleven items loaded very strongly on factor 1 with the following coefficients (given in brackets): Q1 (0.952), Q2 (0.896), Q3 (0.869), Q4 (0.848), Q5 (0.782), Q6 (0.772), Q7 (0.692), Q8 (0.666), Q9 (0.658), Q13 (0.439), and Q12 with a coefficient of 0.361, which was the least. The central theme of the first ten items was perceived utility or usefulness and the last item, Q12, was on perceived disadvantage. Educators placed more emphasis on the benefits derived from a cell phone with internet services. According to Hair *et al.*, (1998) the difference between the loading coefficients should be at least 0.1 in order for there to

be valid discrimination between them. Question 2 cross-loaded strongly under factor 2, and the difference between the cross-loading of factor 1 and factor 2 on Q2 was 0.624, loaded with factor 3 and the difference between them was 0.469, so it was considered under both factors. Item Q7 cross-loaded on factors 1, 2, 3 and 4 and the differences between item Q7 and the three items 2, 3 and 4 were 0.261, 0.199 and 0.274 respectively. Since the differences between item Q7 and items 2, 3 and 4 were all greater than 0.1 it was considered under all four factors. Item Q12 cross-loaded strongly on factor 2 and factor 3 and the differences of the coefficients were 0.407 and 0.466, which are greater than 0.1, so item Q12 was considered under all three of factors 1, 2 and 3. Item 13 cross-loaded strongly with factors 1, 2 and 4, and the differences between factor 1's coefficient and the coefficients of factors 2 and 4 were 0.265 and 0.202 respectively, which were both greater than 0.1. Therefore the researcher had to include item Q13 under all three of factors 1, 2 and 4.

Eleven items loaded strongly on factor 2 with the following coefficients (given in brackets): Q2 (0.327), Q5 (0.316), Q7 (0.431), Q9 (0.466), Q10 (0.919), Q11 (0.842), Q12 (0.768), Q13 (0.704), Q14 (0.657), Q16 (0.424) and Q17 (0.368). The theme for factor 2 was perceived appreciation, attitudes and beliefs. Item 16 cross-loaded strongly on factors 2, 3 and 4. The difference between factors 2 and 3 was 0.332, and that between factors 2 and 4 was 0.355. Question 17 cross-loaded strongly with factors 3 and 4. The difference in coefficients between factors 2 and 3 was 0.332 and between factors 2 and 4 it was 0.355. These differences were significantly greater than 0.1, so the researcher considered them under all three of factors 2, 3 and 4. Factor 3 measured the perceived attitudes, benefits and disadvantages. Nine items loaded strongly on factor 2 with the following coefficients (given in brackets): Q3 (0.341), Q6 (0.303), Q7 (0.493), Q8 (0.310), Q12 (0.322), Q14 (0.615), Q15 (0.929), Q16 (0.756) and Q 17 (0.612). Seven items loaded strongly onto factor 4 (coefficients in brackets): Q8 (0.392), Q9 (0.450), Q11 (0.313), Q13 (0.502), Q16 (0.401), Q17 (0.595) and Q18 (0.920). The theme for factor 4 was based on perceived benefits and influence from outside.

The questionnaire consisted of 18 items made up of closed-form items put on a 5-point Likert scale offering *strongly agree*, *agree*, *undecided*, *disagree* and *strongly disagree* (see Appendix X).

Table 4.22: Descriptive statistics (educators): frequency and percentages
(percentages in brackets)

	Questionnaire item	Strongly Agree [5]	Agree [4]	Undecided [3]	Disagree [2]	Strongly Disagree [1]	N
1	I have a good knowledge of the use of a cell phone with internet services.	4 (44.4)	5 (55.6)	0 (0.0)	0 (0.0)	0 (0.0)	9
2	I enjoy reading Physical Sciences using a cell phone with internet services.	2 (22.2)	5 (55.6)	1 (11.1)	1 (11.1)	0 (0.0)	9
3	Cell phones with internet services are fun, interesting and convenient in Physical Sciences teaching and learning.	1 (11.1)	4 (44.4)	4 (44.4)			9
4	Cell phones with internet services help learners to understand Physical Sciences concepts better.	3 (33.3)	5 (55.6)	1 (11.1)			9
5	Cell phones with internet services give learners the opportunity to study Physical Sciences at their own pace anywhere and at any time.	5 (55.6)	3 (33.3)	1 (11.1)			9

6	I always communicate with my learners doing Physical Sciences with my cell phone with internet services.		7 (77.8)	2 (22.2)			9
7	Mobile Physical Sciences is an effective and efficient method of learning Physical Sciences.		6 (66.7)	3 (33.3)			9
8	Cell phones with internet services can improve Physical Sciences performance.		7 (77.8)	2 (22.2)			9
9	Cell phone programmes give me more time to help my Physical Sciences learners.	2 (22.2)	5 (55.6)	1 (11.1)	1 (11.1)		9
10	A cell phone with internet services is a quicker method of getting feedback in Physical Sciences.	3 (33.3)	5 (55.6)		1 (11.1)		9
11	Learners do many Physical Sciences exercises because cell-phone use is interesting to them.		5 (55.6)	2 (22.2)	2 (22.2)		9
12	Cell phones with internet services improve communication	1 (11.1)	7 (77.8)	1 (11.1)			9

	between a learner and the educator.						
13	Cell phones with internet services cannot be used due to unavailability of cell phones to learners.		2 (22.2)	2 (22.2)	3 (33.3)	2 (22.2)	9
14	Cell phones with internet services cannot be used due to expenses involved in mobile learning.		1 (11.1)		5 (55.6)	3 (33.3)	9
15	Cell phones with internet services cannot be used due to poor network in the villages.		1 (11.1)	4 (44.4)	2 (22.2)	2 (22.2)	9
16	Cell phones with internet services cannot be used due to abuse by learners in the schools.		1 (11.1)	3 (33.3)	4 (44.4)	1 (11.1)	9
17	Cell phones with internet services cannot be used because they take teachers' jobs.		2 (22.2)	1 (11.1)	1 (11.1)	5 (55.6)	9
18	I enjoy participating in Physical Sciences cell-phone learning and teaching.		6 (66.7)	3 (33.3)			9

Table 4.22 provides an overview of the frequencies and percentages of educators' statistics on the use of cell phones in the teaching and learning of Physical Sciences. Responses to each of the indicators on cell-phone use in the teaching and learning of

Physical Sciences are shown measured on a Likert scale of 1 to 5 ranging from *strongly agree* to *strongly disagree*.

All the educators (N=9) agreed on item 1 (see table 4.29). 77.8% (N=7), 55.5% (N=5), 88.9% (N=8), 88.9% (N=8), 77.8% (N=7), 66.7% (N=6), 77.8% (N=7), 77.8% (N=7), 88.9% (N=8), 55.6% (N=5) and 88.9% (N=8) of the educators expressed agreement on items 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 respectively. The educators reflected strong beliefs and attitudes towards the use of cell phones with internet services in the teaching and learning of Physical Sciences.

However, in items 2, 9 and 10, 11.1% (N=1) of the educators showed strong negative attitudes towards the use of cell phones, and on item 10, 22.2% (N=2) of the educators expressed negative attitudes towards the use of cell phones with internet services. The percentage of educators who reflected negative attitudes was very small compared with that of those who had positive attitudes. One educator was undecided on the continued use of cell phones in the teaching of Physical Sciences. On the whole, the researcher deduced that educators had positive beliefs and attitudes towards the use of cell phones with internet services in the teaching and learning of Physical Sciences. These findings concur with those of Pollara and Broussard (2011), who found that mobile learning improved learning performance and learning experiences and made the learning process more interesting for the learners.

Furthermore, 22.2% (N=2) of educators indicated on items 13 and 17 that the disadvantages of cell phones and their abuse by learners should not stop the use of cell phones with internet services in the teaching and learning of Physical Sciences. Also, 11.1% (N=1) of educators indicated on items 14, 15 and 16 that the disadvantages of cell-phone use should not hinder its application in the teaching and learning of Physical Sciences.

Table 4.23: Item statistics

	Mean	Standard deviation	N
Q1) I have a good knowledge of the use of a cell phone with internet services.	4.44	0.527	9
Q2) I enjoy reading Physical Sciences using a cell phone with internet services.	3.89	0.928	9
Q3) Cell phones with internet services are fun, interesting and convenient in Physical Sciences teaching and learning.	3.67	0.707	9
Q4) Cell phones with internet services help learners to understand Physical Sciences concepts better.	4.22	0.667	9
Q5) Cell phones with internet services give learners the opportunity to study Physical Sciences at their own pace anywhere and at any time.	4.44	0.726	9
Q6) I always communicate with my learners doing Physical Sciences with my cell phone with internet services.	3.78	0.441	9
Q7) Mobile Physical Sciences is an effective and efficient method of learning physical sciences.	3.67	0.500	9
Q8) Cell phones with internet services can improve Physical Sciences performance.	3.78	0.441	9
Q9) Cell phone programmes give me more time to help my Physical Sciences learners.	3.89	0.928	9
Q10) A cell phone with internet services is a quicker method of getting feedback in Physical Sciences.	4.11	0.928	9
Q11) Learners do many Physical Sciences exercises because cell-phone use is interesting to them.	3.33	0.866	9
Q12) Cell phones with internet services improve communication between a learner and the educator.	4.00	0.500	9
Q13) Cell phones with internet services cannot be used due to unavailability of cell phones to learners.	2.44	1.130	9

Q14) Cell phones with internet services cannot be used due to expenses involved in mobile learning.	1.89	0.928	9
Q15) Cell phones with internet services cannot be used due to poor network in the villages.	2.44	1.014	9
Q16) Cell phones with internet services cannot be used due to abuse by learners in the schools.	2.44	0.882	9
Q17) Cell phones with internet services cannot be used because they take teachers' jobs.	2.00	1.323	9
Q18) I enjoy participating in Physical Sciences cell-phone learning and teaching.	3.67	0.500	9

The mean scores of Qq. 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 17 and 18 were very high, showing that educators agreed with the statements given regarding the benefits or the utility of cell phones in the teaching and learning of Physical Sciences. The mean scores on Q5 and Q12, which measured usage and communication, were comparably high. However, for Qq. 13, 14, 15 and 16 the mean scores were low, indicating that educators did not consider the matters raised in these questions a serious hindrance to the use of cell phones with internet services in the teaching of Physical Sciences. The standard deviations for Qq. 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 17 and 18 were similar, reflecting very little variability. The standard deviation for Q15 was very high (1.435), suggesting more variability for this item. By contrast, Q8 had the lowest (0.598), signifying low variability and suggesting that the educators strongly believed that the use of cell phones with internet services might help them to improve the pass rate in Physical Sciences despite the disadvantages faced.

Table 4.24: Summary item statistics

	Mean	Minimum	Maximum	Range	Maximum / minimum	Variance	N of items
Item means	3.451	1.889	4.444	2.556	2.353	0.685	18
Item variances	0.662	0.194	1.750	1.556	9.000	0.180	18

A mean of 3.451 and a standard deviation of 0.814 were obtained for the 18 items. The standard deviation was small, showing that there was very little variability and that the educators strongly supported the use of cell phones with internet services in the teaching of Physical Sciences. Their maximum was 4.444 and the minimum was 1.889 with a small range of 2.555 reflecting a normal dispersion.

Table 4.25: Gender

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Male	4	44.4	44.4	44.4
	Female	5	55.6	55.6	100.0
	Total	9	100.0	100.0	

Of the educators who participated, 44.4% (N=4) were male and 55.6% (N=5) were female. Although the female educators outnumbered the male educators by one, the sample was fairly balanced to get views from both genders. Figure 4.13 gives a graphic view of the results.

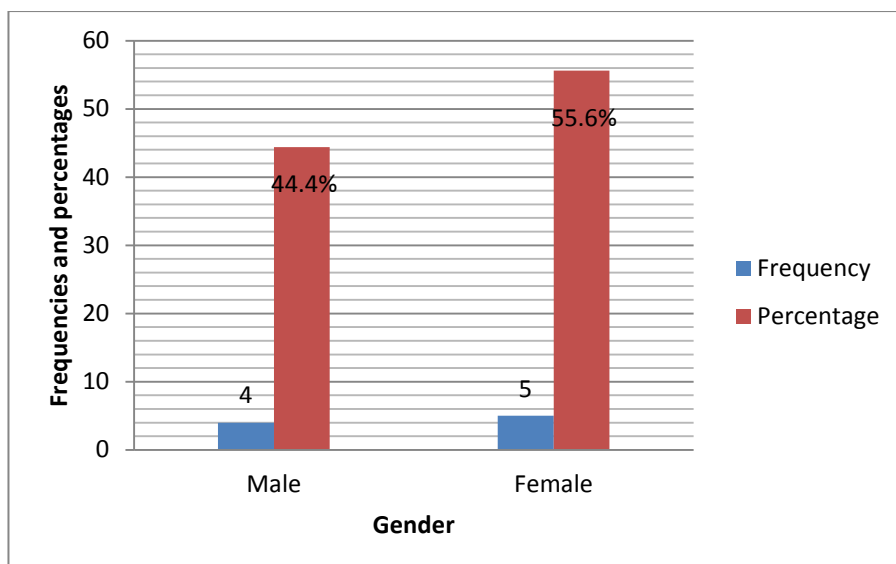


Figure 4.13: Frequency and percentages

Table 4.26: Age

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	23	1	11.1	11.1	11.1
	25	1	11.1	11.1	22.2
	27	1	11.1	11.1	33.3
	29	1	11.1	11.1	44.4
	34	1	11.1	11.1	55.6
	37	1	11.1	11.1	66.7
	40	1	11.1	11.1	77.8
	48	1	11.1	11.1	88.9
	60	1	11.1	11.1	100.0

The educators' ages ranged from 23 to 60.

Table 4.27: Highest qualification in sciences

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	ACE/Diploma	3	33.3	33.3	33.3
	First degree	4	44.4	44.4	77.8
	Honours degree	2	22.2	22.2	100.0
	Total	9	100.0	100.0	

The educators' profile shows that three people had diploma-level qualifications, four had first degrees and two had higher degrees in science subjects. The findings revealed that the educators were adequately qualified to teach Physical Sciences.

Table 4.28: Do you have a cell phone with internet services?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Yes	9	100.0	100.0	100.0

All the educators had cell phones with internet services. This placed them in the correct position to help the learners in the use of these instruments in Physical Sciences learning and teaching.

Table 4.29: Do you use a cell phone with internet services for Physical Sciences teaching?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Yes	9	100.0	100.0	100.0

All the educators said that they used their cell phones in the teaching and learning of Physical Sciences. The researcher concluded that the educators were actively involved in using cell phones in their teaching.

Question: If “Yes”, how many times a week do you use a cell-phone programme to help your Physical Sciences learners?

Most of the educators indicated that they used their cell phones at least three times a week, and only one used theirs only once or twice a week (see figure 4.14).

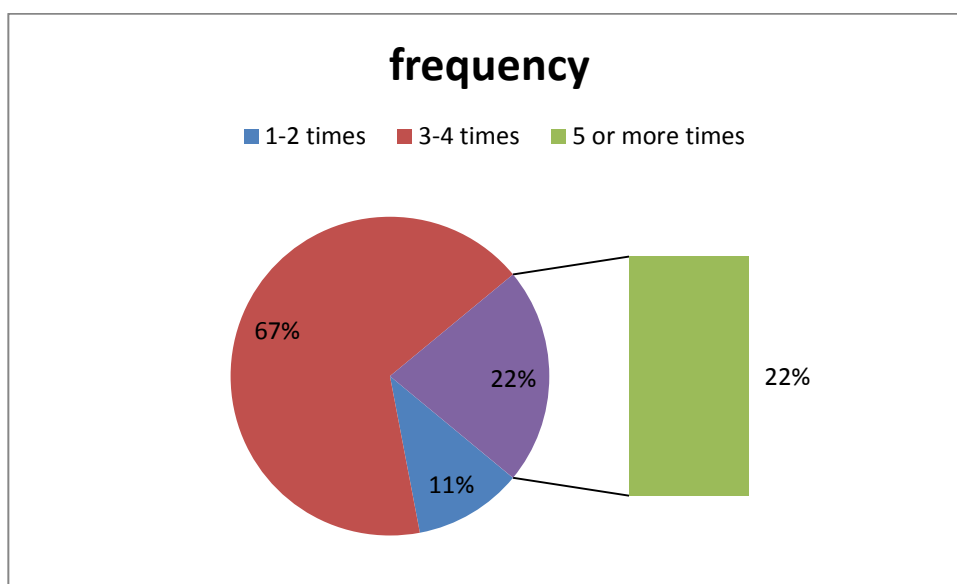


Figure 4.14: Number of times per week educators help learners by using cell phones

Table 4.30: How many times a week do you send SMS comments to your learners?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	1-2 times	5	55.6	55.6	55.6
	3-4 times	3	33.3	33.3	88.9
	5 or more times	1	11.1	11.1	100.0
	Total	9	100.0	100.0	

Five educators reported that they sent few SMS comments via their cell phones. The researcher concluded that this showed that these educators were not strongly inclined towards using SMSs in the teaching and learning of Physical Sciences. Nevertheless he found the correspondences between the learners and educators on the question of SMSs to be encouraging.

Table 4.31: Do you think cell phones with internet services help your learners to pass Physical Sciences?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Yes	7	77.8	77.8	77.8
	Not sure	2	22.2	22.2	100.0
	Total	9	100.0	100.0	

Seven educators believed that the use of cell phones would help learners to pass Physical Sciences, while two were not sure. The researcher decided that the concerns of the two educators who remained unsure needed to be investigated through the interview schedules.

Table 4.32: Do you think cell phones with internet services should be used for Physical Sciences learning in all schools?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Yes	6	66.7	66.7	66.7
	Not sure	3	33.3	33.3	100.0
	Total	9	100.0	100.0	

Six educators said that cell phones with internet services should be used for Physical Sciences learning in all schools, while three educators were undecided. The three who were undecided said that the use of cell phones still needed to be given time in order to become unanimously accepted.

Table 4.33: Do you think cell-phone learning can cause indiscipline in schools?

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Yes	4	44.4	44.4	44.4
	No	3	33.3	33.3	77.8

	Not sure	2	22.2	22.2	100.0
	Total	9	100.0	100.0	

Four of the educators believed that cell phones might cause indiscipline in schools, while three disagreed and three were not sure. The researcher concluded that discipline could be upset through the use of cell phones with internet services in the teaching and learning of Physical Sciences.

Table 4.34: Group Statistics

	Group	N	Mean	Standard deviation	Standard error mean
Perception score	Educator	9	3.4522	0.36152	0.12051
	Learner	338	3.8443	0.41487	0.02257

The mean score of the nine educators was 3.4522 and the standard deviation was 0.36152. The mean of the educators was small, which gave very little variability. On the other hand, 338 learners had a mean of 3.8443 and a standard deviation of 0.41487, which also allowed for very little variability. This meant that, on average, both learners and educators showed favourable perceptions of the use of cell phones with internet services in Physical Sciences learning and teaching. The perception mean score of the learners was higher than that of the educators by 0.3921 points. The researcher concluded that the learners' perceptions of cell-phone use in learning Physical Sciences were more positive than those of the educators.

4.4.3 Comparison of learners' and educators' perceptions of cell-phone use (t-test)

Table 4.35: Independent sample test

		Levene's test for equality of variances		t-test for equality of means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Perception score	Equal variances assumed	.283	.595	-2.806	345	.005	-.39213	.13973	-.66695	-.11730
	Equal variances not assumed			-3.198	8.571	.012	-.39213	.12260	-.67160	-.11265

From Levene's test, $F = 0.283$, which is a small value, and $p = 0.595 > 0.05$. This means that the differences between the two variances are so small that they are likely to have occurred by chance. Therefore the means are representative of their respective groups. $P > 0.05$ means that Levene's test is not significant. Hence, the researcher could go on to perform a t-test confident that the data did not suffer from inhomogeneity of variance.

The t-test produced a p-value equal to 0.006 (1-tailed), which meant that the difference between perception mean scores of educators and learners was statistically significant at 0.1, 0.05, 0.02 and 0.01 levels of significance (see table 4.35). The t-value obtained was negative because of the way the two groups were coded. If the researcher had exchanged the codes ("1 = learner" and "2 = educator"), the same value of t would have been obtained that was positive.

The 95% confidence interval of the difference in perception mean scores was -0.6716 to -0.11265. This means that, if the same research study were done many times, the magnitude of the differences in perception mean scores between the educators and learners could be expected to vary somewhat, but in 95% of the studies, the learners would reflect a more positive perception of the use of cell phones with internet services in learning Physical Sciences than the educators.

4.4.4 Analysis of open-ended questionnaire and interview

The researcher used verbatim transcripts of interviews and written responses to open-ended questions to add more value to data collected from closed-ended questions. The researcher used the data from interviews and open-ended questions to determine the learners' and educators' knowledge of use and benefits, appreciation of use, advantages and disadvantages of use, and motives for implementation or non-implementation of cell phones with internet services in the teaching and learning of Physical Sciences. Thematic analysis was used. According to Braun and Clarke (2006), thematic analysis is a recursive six-step approach to data analysis. It involves familiarization with the initial data, generating codes, searching for themes, reviewing themes, defining and naming themes to produce a report.

Perceptions of the use of cell phones with internet services were coded in relation to the following themes: perceived knowledge on benefits of use, perceived knowledge on appreciation of use, perceived knowledge on disadvantages and perceived knowledge on implementation (see table 4.36).

Table 4.36: Coding scheme for the perceptions of cell-phone use (Source: Mabilangan, Limjap & Belecina, 2011; Creswell *et al.*, 2011)

Category	Variable name	Explanation
Perceived knowledge of benefits and advantages	PKB	Relevant explanations on benefits through use of cell phones in the teaching and learning of Physical Sciences
Perceived knowledge of	PKA	Ability to use, enjoyment of cell

appreciation of use		phone through use, and ability to get question responses through internet
Perceived knowledge of disadvantages	PKD	Relevant examples and explanations on the perceived disadvantages of the use of cell phones
Perceived knowledge of implementation	PKI	Relevant explanations on the need to continue using or to abandon the use of cell phones

The researcher then classified the perceptions of educators and learners into two main categories: positive perceptions and negative perceptions (see table 4.37).

Table 4.37: Classification of perceptions of cell-phone use

Positive perceptions	Negative perceptions
Learner and educator reflect on evidence of good use and advantages, with clear and appropriate examples. Learner and educator like, and propose improvement, implementation and widening of use.	Learner and educator reflect on evidence of bad use and disadvantages, with clear and appropriate examples. Learner and educator do not like, and discourage implementation.

Classification of perceptions, (Creswell *et al.*, 2011 & Ngulube 2013)

Nevertheless, Braun and Clarke (2006) argue that it is not possible to free the researcher from theoretical orientation. This means that the themes identified were influenced by the researcher's theoretical interest in the area of study.

The extracts of learners' and educators' responses were used as evidence of perceptions held by the learners and educators (see section 4.4). Learners' and educators' repeated pattern of responses revealed their predominant set of perceptions. Data collected were assessed and confirmed by methodical triangulation. This was done through the use of questionnaires and interview schedules to collect data (Creswell, 2012; Ngulube, 2013). The researcher had to check whether the data collected from the different sources were bringing him to the same conclusion.

Through triangulation the researcher had to find out if the study's findings and interpretations were similar to or different from those of other researchers (Ngulube, 2013).

4.4.5 Analysis of open-ended responses from questionnaires

The researcher discusses the positive and negative perceptions of learners and educators regarding cell-phone use in the teaching and learning of Physical Sciences. Extracts from learners' and educators' written work are presented as evidence in relation to the researcher's discussion and interpretations. Learners' and educators' responses to open-ended questionnaire and interview schedules are quoted as evidence relating to the arguments raised and findings discovered by the researcher. Lastly, the researcher discusses the relationships between learners' and educators' perceptions of cell-phone use in the teaching and learning of Physical Sciences.

4.4.5.1 Learners' perceptions of cell-phone use in the teaching and learning of Physical Sciences

4.4.5.1.1 Positive perceptions

The researcher focused on what learners and educators said about the benefits of and motives for the implementation of cell-phone use in the teaching and learning of Physical Sciences (see table 4.37). The learners and educators freely expressed their views on the benefits and advantages of and the motives for cell-phone use. Here are some of the responses obtained from the study. (Questionnaires were numbered from Id 1 to Id 140.)

Question: Do you think cell phones with internet services help you to pass Physical Sciences?

Id 26: Yes, because since I started using a cell phone with internet services for Physical Sciences learning I passed Physical Sciences tests.

Id 77: Yes. It is interesting and explains things more clearly and makes them easier to understand.

Id 100: Yes. I think cell phones with internet services are more effective than the books because they show all the steps.

Id 123: Yes. I think cell phones with internet services give extra and simple information.

Id 128: Yes. I passed my recent test with 80% because I am now using my cell phone with internet services to study Physical Sciences.

Id 135: Yes. A cell-phone internet service is easy and helps with information in a good way.

Id 140: Yes. I understand it better than the teacher.

Id 220: Yes. It gives picture information as well as video.

Id 225: Yes. Because when the teacher is not there it helps, and also teacher can send us work to do.

The researcher concluded that learners had positive perceptions of the use of cell phones with internet services in the teaching and learning of Physical Sciences. The learners were aware of the advantages of using cell phones with internet services in their learning of Physical Sciences and showed that they enjoyed it. Baya'a and Daher (2009) state similar advantages of mobile phones.

Question: Do you think cell phones with internet services should be used in all schools for Physical Sciences learning and teaching?

Id 26: Yes because cell phones with internet services make learners pass.

Id 128: Yes. I am now passing Physical Sciences with high marks because I am using my cell phone with internet services to study.

Id 140: Yes. I think cell phones with internet services give better service than a teacher.

Id 135: Yes because some learners understand better cell phone information than teacher information or textbook.

Most learners agreed that cell phones with internet services should be used in all schools, while a few did not agree. There were also a few who remained neutral.

4.4.5.1.2 Negative perceptions

A few learners did not agree that cell phones with internet services helped them to pass Physical Sciences: for example, learners with the following responses:

Question: Do you think cell phones with internet services help you to pass Physical Sciences?

Id 11: No. Sometimes cell phones' internet services do not work due to poor network or battery being flat. They have small screens to read from.

Id 107: No because there are schools which do not allow learners to use cell phones.

The learners realized the problems associated with cell-phone use and thought cell phones would not improve their results. Maniar *et al.*, (2008) and Common Sense Media (2010) have suggested similar disadvantages. However, the results of this study show that most of the learners were quite contented with their cell phones and were enjoying using them for their lessons. Some learners were silent on whether cell phones improved their performance.

Question: Do you think cell phones with internet services should be used in all schools for Physical Sciences learning and teaching?

Id 11: No. I am not sure because some learners and parents cannot afford cell phones.

Learner Id 11 did not support the implementation of cell-phone use in the teaching of Physical Sciences mainly because of the costs involved. The researcher concluded that although most of the learners supported the implementation of cell-phone use in schools, there were a few who did not support it.

4.4.6 Analysis of focus-group interview responses from the learners

4.4.6.1 Learners

The learners' focus-group interviews schedule also focused on perceived knowledge of benefits, perceived knowledge of appreciation, perceived knowledge of disadvantages and perceived knowledge of implementation of cell-phone usage in the teaching and learning of Physical Sciences.

4.4.6.1.1 Positive perceptions

Positive responses were obtained from learners and educators on cell-phone usage in Physical Sciences learning. Learners indicated that they used their cell phones to record results, photograph notes from the teacher for future use, receive and send texts, record lessons, access the internet, transfer files between home and school, and serve as a stopwatch during experiments (Hartnell-Young & Heym, 2008). The following were some of the responses obtained from focus groups (focus groups were numbered from GpId 1 to GpId 5).

Interviewer: What is good about using cell phones with internet services in learning Physical Sciences?

GpId 1: We will be able to verify science information on the internet.

GpId 2: We will be able to see visual examples rather than see just theories and by so doing we will understand science better.

GpId 3: We can use our cell phones to download science materials that assist us in our study.

GpId 4: We can access online science lessons.

GpId 5: We can access different science lessons rich in knowledge.

Learners gave clear examples and explained the benefits of cell-phone use in science. They showed that they were quite conversant with the use of cell-phone internet services and enjoyed it.

Interviewer: Do you think cell phones with internet services should be used for Physical Sciences learning and teaching in all schools?

GpId 1: Yes, because cell phones with internet services help us to compare information from the teacher with that from cell phones.

GpId 2: Yes. Cell phones with internet services make studying simple.

GpId 3: Yes. It gives the learners the opportunity to concentrate on their own without the supervision of the teacher.

GpId 4: Yes. Cell phones with internet services give quick feedback on exercises and tests.

GpId 5: Yes. Some learners understand cell information better than teacher information or the textbook.

From the above responses the researcher concluded that most of the learners were quite aware of the benefits of cell-phone use in the teaching and learning of Physical Sciences. The learners had positive attitudes and beliefs regarding cell-phone usage in the teaching and learning of Physical Sciences. The learners stated that cell phones with internet services gave them both visual and explicit information which made their learning easy.

4.4.6.1.2 Negative perceptions

Nevertheless some learners during interviews said that ignorance, fear of the unknown, cell-phone abuse and lack of school policy hampered the implementation of cell-phone usage in all subjects. The following were some of the disadvantages cited by learners.

Interviewer: What is bad about using cell phones with internet services in learning Physical Sciences?

GpId 1: We sometimes use cell phones for WhatsApp, Facebook, Twitter, WeChat and Instagram and watching explicit pornographic videos instead of for studying.

GpId 2: Some of us without parents and who are poor cannot afford the expenses involved in using cell phones with internet services.

GpId 3: Some learners can use it for criminal activities such as stealing and bullying.

GpId 4: There are some of us “learners” who can use it for cheating during examinations.

GpId 5: Sometimes poor network service disturbs our study.

Interviewer: Do you think cell phones with internet services should be used in all schools for Physical Sciences learning and teaching?

GpId 4: No. Not sure, because some learners and parents cannot afford cell phones with internet services.

The learners gave explicit views on the disadvantages of cell-phone use but still believed that cell phones were important devices in their learning of Physical Sciences. There was one group which did not agree with the implementation of cell-phone use in the teaching of Physical Sciences in all schools.

4.4.7 Analysis of educators’ interview

4.4.7.1 Perceptions of use of cell phones

4.4.7.1.1 Positive perceptions

The researcher numbered the educators from EId 1 to EId 3 for the interview. The following were some of the responses that came from the educators.

Interviewer: What is good about using cell phones with internet services in teaching and learning Physical Sciences?

EId 1: Learners can expand knowledge through online resources.

EId 2: Cell phones provide a variety of approaches to explain different concepts. I also use it for science reference purposes.

EId 3: Instruments or equipment not in the school can easily be googled from the internet and seen. Also through your tube, experiments can be done physically while learners observe.

The responses of educators reflected an understanding of the benefits of cell-phone use. Some of them also indicated that they used cell phones for reference purposes.

4.4.7.1.2 Negative perceptions

Interviewer: What is bad about using cell phones with internet services in learning Physical Sciences?

Eld 1: Learners lose their attention on the teacher and concentrate on the cell phone.

Eld 2: Learners tend to use cell phones for social interaction, boyfriend and girlfriend relationships or even for watching explicit pornography.

Eld 3: Cell-phone information tends to reduce creativity and internalization of knowledge by encouraging learners to be too dependent and reliable on cell-phone teaching.

Interviewer: Do you think cell phones with internet services should be used for teaching and learning Physical Sciences in all schools? Please support your answer.

Eld 1: Yes. Because cell phones make my work easy by reducing the marking load and I get time to monitor and help learners individually. Nevertheless good school policy needs to be drawn to up control cell-phone use.

Eld 2: Yes, but there must be some control policy. Learners' cell phones must not access functions such as WhatsApp, Facebook, Twitter or We-Chat.

Eld 3: Yes. But schools and the Education Department must help to meet some of the costs involved in using cell phones for learning purposes.

Most of the educators approved of the use of cell phones with internet services in the learning of Physical Sciences. However, they expressed concerns about the control mechanism that should be used to curb abuse of cell phones by learners. They agreed that some regulatory policy must be drawn up and that the Department of Education must help with the cost of cell phones.

One educator did not support the use of cell phones in learning. However, he agreed that they could be used for reference purposes.

Interviewer: Do you think cell phones with internet services should be used for teaching and learning Physical Sciences in all schools? Please support your answer.

EId 3: No. However, it should be used for or limited to referencing because it might promote criminal activities such as bullying or other cybercrimes.

4.4.8 Positive perceptions on the implementation of cell-phone use

Interviewer: How can we best implement mobile Physical Sciences programmes in teaching and learning?

EId 1: Schools should have an administrator who controls cell-phone activities in class.

EId 2: The Government should supply cell phones with internet services to all schools to cater for all learners; e.g. Gauteng's Education Department is supplying all learners in its schools with tablets.

EId 3: Teachers and learners should be workshopped on the proper use of cell phones during lessons.

In general all the educators except one supported the implementation of cell-phone use in schools. They recommended some control measures to stop the abuse of cell phones by learners and to support learners in their learning.

4.4.9 Summary of discussions of findings

The learners and educators showed that they liked the use of cell phones with internet services in the teaching and learning of Physical Sciences. Data from the research show that both learners and educators possess these devices and have been using them positively for the study of Physical Sciences. The findings show that the learners and educators both use cell phones for communication, research, lesson preparation, demonstrations, experiments and extra lessons. They all value the convenience and capabilities which come with cell phones' usage. As a result most of them recommended its implementation in the teaching and learning of Physical Sciences.

The answers provided on the questionnaires and in the interviews were similar. Both the learners and the educators said that cell phones were convenient, user-friendly, resource-rich and enjoyable. There were more of the perceived benefits presented than the disadvantages. However, both the learners and the educators reflected a general concern about the abuse of cell phones by some learners, and the shortage or lack of cell phones that affects some disadvantaged learners. The educators were very particular about the need for a strict school policy to control the use of cell phones in the learning and teaching process, the need to train both educators and learners in the proper use of cell phones for learning, and the need for the Department of Education to supply programmed cell phones for learning purposes. In addition the educators suggested campaigns to persuade everyone concerned in schooling to accept cell-phone usage as a necessity in teaching and learning in schools.

On the whole, the educators and learners revealed strongly positive perceptions of the use of cell phones in the teaching and learning of Physical Sciences. A strong perception will result in positive beliefs and attitudes towards cell-phone technology (Vatanparast, 2009).

The researcher concluded that data gathered from study showed that the educators and learners supported cell-phone use for Physical Sciences learning. They all agreed that cell phones should be accessible as learning tools both in and out of the classroom. They concurred that cell phones support the effective learning of Physical Sciences.

4.4.10 Discussion of results in relation to the literature

The literature review in Chapter 2 laid the foundations for the study of the perceptions of learners and educators regarding the use of cell phones with internet services in the teaching and learning of Physical Sciences. The findings of various scholars were noted. The challenge existed between correct usage and abuse of cell phones in the teaching and learning process. The learners and educators agreed that a control policy must be formulated and applied.

They also alluded to the fact that correct usage demands training for both educators and learners. It was observed that learners communicated, researched and did extra

lesson exercises with cell phones inside and outside school (Prensky, 2010). However, the educators seemed to think that the cell phones were being used for non-educational purposes. The learners and educators agreed that cell phones would cause classroom disruption if usages were not properly controlled and learners and educators were not properly trained. As matters stand, schools are reluctant to take on the extra responsibilities of costs and control.

If cell-phone use were allowed, schools would continually be challenged by learners cheating in examinations, taking unauthorized pictures and watching pornography, and shortages of cell phones through theft would also be common (Common Sense Media, 2010; BMR, 2012). Nevertheless learners and educators want to use cell phones for learning purposes. Therefore regulatory measures should be put in place (BMR, 2012). Cell phones have become an integral part of learners' everyday lives; as a result, they should be embraced for learning and teaching in schools (Ting, 2007). Instead of grappling with a policy which discourages the implementation of cell-phone learning, school authorities should generate policies for its adoption.

The findings of this study show that both the educators and the learners supported the use of cell phones with internet services in the learning and teaching process. They concurred that it could be pivotal in raising pass rates in Physical Sciences. The perceptions expressed by the learners and educators regarding the use of cell phones were positive and similar. Almost all of the learners and educators concerned viewed cell phones as indispensable tools for the learning processes in schools. This is in agreement with Attewell (2005), who argues that cell phones with internet services benefit learners of all ages.

4.4.11 Chapter summary

The researcher discovered that the learners and educators held similar views on cell-phone use in the teaching of Physical Sciences. They had strongly positive perceptions of cell-phone use. Their attitudes and beliefs showed that they want cell phones with internet services to be used for the teaching and learning of Physical Sciences despite the challenges which face the implementation thereof. Data were presented in different forms such as tables, diagrams, direct quotes from

questionnaires and interviews, and extracts of written responses. Coding, factor analysis, cluster analysis, thematic analysis, independent sample tests and methodological triangulation were used. The perceptions of the learners and the educators were noted and interpreted. The next chapter looks at conclusions and recommendations.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

In this chapter the researcher provides a summary of the study, followed by the conclusions reached in relation to each research question. He also offers some general recommendations and suggestions that relate to the research findings and could be possibly used in future in related studies. Lastly he touches on the limitations of the study and gives his reflections on it.

5.2 SUMMARY OF THE STUDY

This research study looked at the perceptions of both learners and educators regarding the use of cell phones with internet services in the teaching and learning of Physical Sciences. Three Moretele high schools in the Bojanala district of South Africa's North West province were utilized. The topic was selected on the basis that learners and educators in these schools were engaged in the use of cell phones with internet services in the teaching and learning of Physical Sciences. The use of cell phones with internet services in teaching and learning is a new paradigm providing a shift from the traditional way of teaching, which uses paper and chalkboard, to paperless technology. In general, schools in South Africa have been producing poor results in Physical Sciences (see section 1.1). The use of cell phones with internet services in the teaching and learning of Physical Sciences could be a way to improve pass rates in the subject. The researcher of this study wanted to throw some light on this problem because researchers and educators such as Paul (1995), Prensky (2001) and McDaniel (2012) point to a lack of adequate research on the use of mobile technology in the teaching and learning process. Young (2012), Traxler (2010) and Swan, van 'tHooft, Kratcoski and Chenker (2007) have concentrated on, respectively, barriers to technology, potential use of technology, and acceptance of technology, but they ignore the perceptions of learners and educators regarding the use of cell phones with internet services in the teaching and learning of Science in high schools.

This research was undertaken with a specific focus on Grade 10, 11 and 12 learners and their educators who have been using cell phones with internet services in the teaching and learning of Physical Sciences. The researcher wanted to determine their perceptions, views, and attitudes as to their use of cell phones with internet services in the teaching and learning of Physical Sciences. The research study sought responses to the following research questions.

- ❖ What benefits do learners perceive in the use of cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ What benefits do educators perceive in the use of cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ What drawbacks do learners perceive in the use of cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ What drawbacks do educators perceive in the use of cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ Do learners want to continue using cell phones with internet services in the teaching and learning of Physical Sciences?
- ❖ Do educators want to continue using cell phones with internet services in the teaching and learning of Physical Sciences?

A mixed-approach methodology was adopted whereby both quantitative and qualitative data were collected in a sequential order. The data were used to address the research questions and, as such, a positivist-interpretive perspective was utilized in conducting the study. Responses to questionnaires were provided by nine educators chosen purposely and 345 learners chosen via a random elimination process followed by purposive selection. After this 45 learners were interviewed in groups of five, and three educators were interviewed individually. The selection criteria for the interviews were random, purposive and convenient, based on willingness, good knowledge of the use of cell phones, and experience. The interviewees were taken from the sample of 345 learners and nine educators.

The data collected were analysed and presented in the form of tables, figures, graphs, direct quotes from the learners' and educators' questionnaire responses, excerpts from interviews, and descriptive data on learners' and educators' perceptions of the use of

cell phones with internet services in the teaching and learning of Physical Sciences. The researcher used factor analysis, cluster analysis, coding, organizing data into descriptive themes, noting relations between variables and methodological triangulation to analyse the data (see tables 4.35 and 4.36 and section 4.4).

The learners and educators provided responses reflecting their perceptions of their cell-phone usage. Their attitudes, beliefs and readiness towards cell-phone usage were shown. In general, the research classified their perceptions as either positive or negative, and it was observed that the learners and educators held similar positive views. Almost all of the learners and educators concerned were excited by and enjoyed the use of cell phones with internet services in the teaching and learning of Physical Sciences. The positive views of the learners and educators outweighed their negative views on cell-phone usage. Almost all wanted to continue using cell phones with internet services in the teaching and learning of Physical Sciences despite some challenges they saw as affecting their usage. For example, problems such as cyberbullying and cheating in examinations were mentioned (Common Sense Media, 2010). They proposed the making of policies governing cell-phone usage, advocacy campaigns, and workshops for training both educators and learners in the correct usage of cell phones with internet services in the teaching and learning of Physical Sciences.

5.3 CONCLUSIONS

The use of cell phones in South African schools is now widespread (BMR, 2012). Studies reveal that learners and educators own cell phones with internet services and prefer using them rather than books for their studies (Swan *et al.*, 2007; BMR, 2012). However, current policies in schools discourage them. The educators and learners recognize the challenges they face in their use of cell phones with internet services in teaching and learning. They now need policies and regulations that will enable them to use their cell phones with internet services freely in the teaching and learning process. The advantages of using cell phones with internet services in the teaching and learning of Physical Sciences are seen to outweigh the disadvantages that come with using them. Therefore learners and educators want to use cell phones with internet services for learning. Harnessing the capabilities of cell phones with internet

services would provide great opportunities to both learners and educators to achieve unlimited educational heights. Learners and educators in this research study expressed strong positive perceptions of using cell phones with internet services in the teaching and learning of Physical Sciences. A strong and positive attitude or belief leads to positive use (Vatanparast, 2009; Fishbein & Ajzen, 1975; Ma & Liu, 2004). However, good control policies and training of the educators and learners in the disciplined use of cell phones with internet services should come before implementation.

The majority of educators and learners believed that cell phones with internet services would help them improve pass rates in Physical Sciences. Therefore the researcher concludes that the research question was answered.

5.4 GENERAL RECOMMENDATIONS

In view of the findings of this research study, the researcher recommends the following teaching and learning practices in Physical Sciences:

- ❖ Physical Sciences teaching and learning should involve the use of cell phones with internet services in order to give learners and educators quick references and quick responses to questions, to meet the needs of learners who are reticent or shy in open discussions, and to provide the means of learning anywhere and at any time.
- ❖ Educators should always closely monitor and manage learners in their use of cell phones with internet services to try to minimize misuse on non-educational things. Paul (1995) and Cuban *et al.*, (2001) argue that mobile technology destroys effective learning if not properly monitored. In the light of this warning, schools should establish clear and proper policies and regulations to prevent the abuse of cell phones with internet services by learners. In addition, schools should provide cell phones which are programmed to learning functions only. Learners should be made aware of their responsibilities in learning via cell phones with internet services. Educators should incorporate learners' academic interests in order to promote effective learning using cell phones with internet services in Physical Sciences. Educators should maintain strict monitoring programmes

to help learners in their use of cell phones with internet services. The cell phones with internet services should expose learners to challenging and enriching exercises that keep them busy and motivated to do schoolwork.

5.5 RECOMMENDATIONS FOR FUTURE STUDIES

Based on the findings of this study, the following recommendations are offered:

- ❖ Research and its resulting literature need to be expanded into examining the perceptions of all concerned, such as school administrators, parents, governments and NGOs, regarding the use of cell phones with internet services in teaching and learning.
- ❖ Research and literature need to compare learners' and educators' perceptions with those of other stakeholders such as administrators and parents.
- ❖ Research studies should be carried out on larger samples, for example six or more schools.
- ❖ Research should involve the use of observations as a method of collecting data in schools involved in mobile learning.
- ❖ Studies should be carried out to compare the performance of schools using cell phones with internet services for learning and teaching science with that of schools which are not using cell phones.
- ❖ Studies are needed which assess learners' progress as they move from one grade to the next using cell phones with internet services in their learning.
- ❖ Small-scale international comparative research into learners' and educators' perceptions of cell phones with internet services in the teaching and learning of sciences in high schools would be valuable.

5.6 LIMITATIONS OF THE STUDY

- ❖ The results and findings analysed were all derived from three high schools in the Moretele area. Although similarities to other schools may exist, these results are directly related only to the three schools.

- ❖ The study did not examine the perceptions of school administrators and parents, or of other interested parties, but was limited to just educators and learners. As a result, the outcomes of the study did not include the perceptions of other stakeholders regarding the implementation of cell-phone use in schools. Therefore the research study could not draw wide or full conclusions.
- ❖ Further research is required on this problem which could probably use more learners in the data collection so that further evidence is obtained.

5.10 REFLECTIONS ON THE FINDINGS, AND CONCLUSIONS

The learners and the educators reflected similar positive attitudes and beliefs towards the use of cell-phones in the teaching and learning of Physical Sciences. They all agreed on the importance of cell phones with internet services in the teaching and learning of Physical Sciences. This made it simple for the researcher to determine their general perceptions as positive. The learners gave limited and sometimes unclear views on disadvantages of cell-phone use compared to the educators who were very clear and concise in their explanations. The educators reflected deep understanding of consequences of continued use of cell phones with internet services in the teaching of Physical Sciences. They appreciated the value of such use but they stressed that cell phones with internet services need good control measures in order to be properly used in the teaching and learning process. The study revealed that the learners and educators had strong positive views on the use of cell phones with internet services in the teaching and learning of Physical Sciences. The conclusion is supported by Mtega, Bernard, Msungu and Sanare (2012), O'Malley *et al.*, (2005), Thornton and Houser (2005) and Manzo (2009), but is contradicted by the findings of Cuban *et al.*, (2001), Kim, Rueckert, Kim and Seo (2013) and Kafyulilo (2012). Section 5 highlighted the practical implications of the findings of the study.

REFERENCES

- Aaker , D. A., Kumar, V. and Day, G. S. (1998). *Marketing research* (6th ed.) New York: John Wiley & Sons.
- Adam, D. and Hamm, M. (1999). *Co-operative learning, critical thinking and collaboration across the curriculum*. Illinois: Charles C. Thomas.
- Aderinoye A. R., Ojokheta, O.K. and Olojede, A.A. (2007). Integrating Mobile Learning into Nomadic Education Programmes in Nigeria: Issues and perspectives. *The International Review of Research in Open and Distance Learning*, 8(2).
- Aker, J. (2008). *Does Digital Divide or Provide? The Impact of Cell Phones on Grain Market in Niger*, University of California: Berkeley.
- Alexander, B. (2004). Going nomadic: Mobile learning in higher education. *Educause Review*, 39(5), pp. 28-35.
- Al-Fahad, F. N. (2009). Students' Attitudes and Perceptions towards the Effectiveness of Mobile Learning in King Saud University, Saudi Arabia. *Online Submission*.
- Ally, M. (ed.). (2009). *Mobile learning: Transforming the delivery of education and training*. Alberta, Canada: Athabasca University Press.
- Arbaugh, J. B., Bangert, A. and Cleveland-Innes, M. (2010). Subject matter effects and the Community of Inquiry (CoI) framework: An exploratory study. *The Internet and Higher Education*, 13(1-2), pp. 37-44. doi:10.1016/j.ihteduc.2009.10.06
- Ary, D., Jacobs, L. C., Razavieh, A. and Sorenson, C.K. (2009). *Introduction to Research in Education*. (8th ed.). Belmont, California: Wadsworth Cengage Learning.
- Attewell, J. (2005). *Mobile technologies and learning: A technology update and m-learning project summary*. Retrieved on 12 April 2012 from <http://www.mlearning.org/docs/The%20m-learning%20project%20->
- Bain, A. and Ross, K. (2000). School re-engineering and SAT-1 performance: A case study. *International Journal of Education Reform*, 9(2), pp. 148-153. Retrieved on 12 June 2011 from http://caret.iste.org/index.cfm?fuseaction=evidence&ans_werid=1

- Barker, A., Krull, G. and Mallinson, B. (2005, October 25-28). *A proposed Theoretical Model for M-Learning Adoption in Developing Countries*. Paper presented at the 4th world conference on m-learning (MLearn2005), Cape Town, SA.
- Barker, T. Z. (1994) *Doing Social Research* (2nd ed.). New York: McGraw-Hill, Inc.
- Baya'a, N. and Daher, W. (2009). *Students' perceptions of mathematics learning using mobile phones*. Published in the proceedings of the IMCL's 4th International Conference on Interactive Mobile and Computer-Aided Learning, Amman, Jordan.
- Best, J. W. and Khan, J. V. (2003). *Research in Education*. Boston, Massachusetts: Library of Congress Cataloguing-in-Publication data.
- Borg, W. R. and Gall, M. D. (1998). *Educational Research*. New York, London.
- Botha, A., Herselman, M. and van Greunen, D. (2010). Mobile user experience in an m-learning environment. *Proceedings of the 2010 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists*, Bela Bela, South Africa: ACM, pp. 29-38.
- Botzer, G. and Yerushalmy, M. (2007). *Mobile Applications for Mobile Learning*. Proceedings for "Cognition & Exploratory Learning in Digital Age". (CELDA). Algarve, Portugal.
- Brauer, M. (n. d.) Data analysis: *Factor analysis*. Retrieved on 12 February 2014 from [lapsco.univ-bpclermont.fr/persos/brauer/pdf/HOFactor analysis.pdf](http://lapsco.univ-bpclermont.fr/persos/brauer/pdf/HOFactor%20analysis.pdf)
- Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), pp. 77-101. ISSN:1478-0887.
- Brown, H. T. (2005). *mLearning: Doing the unthinkable and reaching the unreachable!* Ericsson mobile learning conference. Retrieved on 17 October 2013 from http://learning.ericsson.net/mlearning2/thefuture_of_mobile.shtml
- Bryan, A. (2004). Going nomadic: Mobile learning in higher education. *Educause Quarterly*, pp. 29-35.
- Bryman, A. (2011). *Social Research Methods*. Oxford, UK: Oxford University Press.
- BuddeComm. (2012). *South Africa Mobile Market Overview, Statistics and Forecasts*. Retrieved on 11 March 2013 from <http://www.budde.com.au/research/South-Africa-Mobile-Market-Overview-Statistics-and-Forecasts.html>.

- Bureau of Marketing Research (BMR). (2012). *Cell-phone living and learning styles among secondary school learners in Gauteng*. Retrieved on 15 December 2012 from www.unisa.ac.za/Default.asp?Cmd=viewContent+contentID=2359
- Carmichael, P., Fox, A., McCormick R., Procter, R. and Honour, L. (2006). Educators' network in and out of school. *Res.Paper Educ.*, 21(2), pp. 217-234.
- Cassidy, J., Park, R. D., Butovsky, L. and Braungart, J. M. (1992). Family-peer connections -- the role of emotional expressiveness with the family and the children's understanding of emotions, *Child Development*, 63, pp. 603-618.
- Caudill, J. G. (2007). The Growth of m-Learning and the Growth of Mobile Computing: Parallel developments. *International Review of Research in Open and Distance Learning*, 8(2).
- Centre for Development and Enterprise (CDE), (2008). *Doubling for growth: Addressing the mathematics and science challenge in South Africa's schools*. Johannesburg: CDE.
- Chen, J. and Kinshuk. (2005). Mobile Technology in Educational Services. *Journal of Educational Multimedia and Hypermedia*, 14(1), pp. 91-109.
- Chen, J. H., Chang, H. B., Shen, C. Y., Wang, T. W., Chang, W. C. and Shih, T. K. (2010). Immersive learning environment by integrating the interactive video and ubiquitous technologies. *Journal of Convergence Information Technology*, 5(9).
- Chirove, M. (2015) *Relationships between learners' mathematics-related belief systems and their approaches to non-routine mathematical problem solving. A case study of three high schools in Tshwane North District (D3), South Africa*. Unpublished dissertation, University of South Africa.
- Cobcraft, R., Towers, S., Smith, J. and Bruns, A. (2006). Mobile learning in review: Opportunities and challenges for learners, educators and institutions. In *Proceedings of Online Learning and Teaching (OLT) Conference 2006*, pp. 21-30. Queensland University of Technology, Brisbane. Retrieved on 9 May 2012 <https://olt.qut.ed.au/udf/OLT2006/gen/papers/obcroftOLT006paper.p.d.f>

- Cohen, L., Manion, L. and Marrison, K. (2000). *Research Methods in Education*. London: Routledge.
- Common Sense Media. (2010). *Hi-Tech cheating: Cell phones and cheating in schools: a national poll*. Retrieved on 15 July 2011 from <http://www.common sense media.org/hi-tech-cheating>
- Copeland, J. (2011, February). Taking it mobile: Success stories from the new frontier of untethered [sic] learning. *Florida Educational Technology Conference*, Orlando, Florida.
- Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Boston, Massachusetts: Pearson Education, Inc.
- Creswell, J. W., Klassen, A. C., Plano Clark, V. L. and Smith, K. C. (2011). *Best practices for mixed methods research in health sciences*. Washington DC: National Institute of Health.
- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16, pp. 297-334.
- Cuban, L., Kirkpatrick, H. and Peck, C. (2001). High Access and Low Use of Technologies in High School Classrooms: Explaining an Apparent Paradox. *American Educational Research Journal*, 38(4), pp. 813-834.
- Daher, W. M. (2009). Students' perceptions of learning mathematics with cellular phones and applets. *International Journal of Emerging Technologies in Learning*, 4(1), pp. 23-28. Retrieved on 22 April 2012 from <http://onlinejournals.org/i-jet/article/view/686/841>
- Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), pp. 319-340.
- Davis, F. D., Bagozzi, R. P. and Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology*, 22, pp. 1111-1132.
- Dede, C. (2005). Planning for Neomillennial Learning Styles, *EDUCASE Quarterly*, 1, 2005.
- Denzin, N. K. and Lincoln, Y. S. (2000). *Handbook of Qualitative Research* (2nd ed.). California: Sage Publications.

- Department of Arts, Culture, Science and Technology (DACST). (1999). *Feasibility Study for the Establishment of a Network of Science and Arts Centres in South Africa*. Pretoria, SA.
- Department of Basic Education (DBE). (2011). *Curriculum Assessment and Policy Statement (CAPS) Physical Science*. Government Printers, Pretoria
- Department of Basic Education (DBE). (2011). *Report on National Assessment of 2011*. Pretoria: Government Printer.
- Department of Basic Education (DBE). (2013). *Macro Indicator Trends in Schools: Summary Report 2012*. Pretoria: Government Printer.
- Department of Education (DoE). (2001). *National Strategy for Mathematics, Science and Technology Education*. Pretoria: Government Printer.
- Department of Education (DoE). (2010). *National Strategy for Mathematics, Science and Technology Education in General and Further Education and Training*. Pretoria: Government Printer.
- DeVellis, R. F. (1991). *Scale development: Theory and applications*. Newbury Park, California: Sage.
- Dewitt, D. and Siraj, S. (2010). Learners' perceptions of technology for design of collaborative m-learning module. *World Journal on Educational Technology*, 2(3), pp. 169-185. Available online from <http://www.world-education-centre.org/index.php/wjet>
- Dieterle, E., Dede, C. and Schrier, K. (2007). "Neomillennial" learning styles propagated by wireless handheld devices. In: M. Lytras and A. Naeve (eds.), *Ubiquitous and pervasive knowledge and learning management: Semantics, social networking and new media to their full potential*. Hershey, Pennsylvania: Idea Group, Inc.
- Dillman, D. A. (2007). *Mail and Internet Surveys: The Tailored Design Method* (2nd ed). Hoboken, New Jersey: Wiley.
- Duncan-Howell, J. and Lee, K. T. (2007). M-learning: Finding a place for mobile technologies within tertiary educational settings. In *ICT: Providing choices for learners and learning. Proceedings ascilite Singapore 2007*. Retrieved on 24 July 2010 from <http://www.ascilite.org.au/conferences/singapore07/procs/duncanhowell.pdf>

- Duffy, T. M. and Cunningham, D. J. (1996). Constructivism: Implications for the design and delivery of instruction. In: D.H. Jonassen (ed.), *Handbook of research for educational communications and technology*. New York: Macmillan.
- DuVall, J. B., Powell, M. R., Hodge, E. and Ellis, M. (2007). Text messaging to improve social presence in online learning. *Education Quarterly*, 3, p. 24.
- Eagle, N. (2005). *Entrepreneurship and Education through Mobile Phones in Kenya*. Massachusetts: Institute of Technology.
- Ertmer, P. A. and Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, 42(3), pp. 255-284.
- Eskom Development Foundation Report. (2011). *Support to Education. Eskom Mathematics, Science and Technology programme*. Retrieved on 7 March 2012 from http://www.financialresults.co.za/2011/eskom_ar2011/esk
- Fishbein, M. and Ajzen, I. (1975). *Belief, attitude, intention, and behaviour: An introduction to theory and research*. Reading, Massachusetts: Addison-Wesley.
- Fraenkel, J. R. and Wallen, N. E. (2006). *How to design and evaluate research in education* (5th ed.) New York: McGraw-Hill.
- Frاند, J. (2000). The information age mindset: changes in learners and implications for higher education. *Educause Review*, 35(5), pp. 15-24.
- Gall, M. D., Borg, W. R. and Gall, J. P. (1996). *Educational Research. An introduction* (6th edition). London: Longman.
- Gay, L. R. and Airasian, P. W. (2008). *Educational Research: Competencies for Analysis and Application*. New York: Merrill Prentice Hall.
- Geddes, S. J. (2004). Mobile learning in the 21st century: Benefit for learners. *The Knowledge Tree: an e-Journal of Learning Innovation*, 6. Retrieved on 20 August 2006 from <http://knowledgetree.flexiblelearning.net.au/edition06/download/ddes.doc>
- Genossar, S., Botzer, G. and Yerushalmy, M. (2008). Learning with mobile technology: A case study with students in mathematics education. *Proceedings of the CHAIS conference*, Open University (in Hebrew). Retrieved on 14 October 2012 from http://telempubopenu.ac.il/users/chais/2008/evening/3_2.pdf

- George, D. and Mallery, P. (2003). *SPSS for Windows step by step : a simple guide and reference, 11.0 update* (4th ed.). Boston: Allyn and Bacon.
- Georgiev, T., Georgieva, E. and Trajovski, G. (2006). *Transitioning from e-Learning to m-Learning: Present issues and future challenges*. Paper presented at the Seventh ACIS International Conference on Software Engineering, Artificial Intelligence, Networking, and Parallel/Distributed Computing.
- Goh, T. and Kinshuk, D. (2006). Getting ready For Mobile Learning Adaptation Perspective. *Journal of Educational Multimedia and Hypermedia*, 15(2), pp. 175-198. Chesapeake, Virginia: AACE. Retrieved on April 12 2013 from <http://www.edilib.org/p/6179>.
- Golafshani, N. (2003). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report*, 8(4), pp. 597-607.
- Gratton, C. and Jones, I. (2010). *Research Methods for Sports Studies* (2nd ed.). Abingdon, UK: Routledge.
- Gray, D. E. (2009). *Doing Research in the Real World* (2nd ed.). Thousand Oaks, California: Sage Publications Ltd.
- Grayson, D., Harris, L., McKenzie, J. and Schreuder, B. (2014). *Platinum Physical Sciences*. Learners' books. Maskew Miller. Longman.
- Habitzel, K., Mark, T. D., Stehno, B. and Prock, S. (2006). *Micro learning ; Emerging concepts, Practices and Technologies after e-learning*. Proceedings of Micro learning 2005. Learning and Working in New Media, in Conference Series: Innsbruck University Press. Retrieved on 20 August 2010 from <http://www.microlearning.org/micropapers/microlearning>
- Haghirian, P., Madlberger, M. and Tanuskova, A. (2005). *Increasing advertising value of mobile marketing: An empirical study of antecedents*. Paper presented at the 38th Hawaii International Conference on System Sciences.
- Hahn, J. (2008). Mobile learning for the twenty-first century librarian. *Reference Services Review*, 36(3).
- Hair, J. F., Bush, R. P. and Ortinau, D. J. (2000). *Marketing research: A practical approach for the new millennium*. Singapore: McGraw-Hill.
- Hair, J. F., Anderson, R. E., Tatham, R. L. and Black, W. C. (1998). *Multivariate Data Analysis*. New Jersey: Prentice Hall.

- Harrison, D. A., Mykytyn Jr, P. P. and Riemenschneider, C. K. (1997). Executive decisions about adoption of information technology in small business: Theory and empirical tests. *Information Systems Research*, 8(2), pp. 171-195.
- Hartnell-Young, E. and Heym, N. (2008). *How Mobile Phones Help Learning in Secondary Schools*. Nottingham: Learning Science Research Institute.
- Harwood, P. G. and Asal, V. (2007). *Education: The first digital generation*. Westport, Connecticut: Prager.
- Hennessy, S., Wishart, J., Whitelock, D., Deane, R., la Velle, L., Hitchcock, G. and Hughes, D. (1989). *Research and the Teacher; A Qualitative Introduction to School-based Research*. London: Routledge.
- Hobbs, V. and Christianson, J. S. (1997). *Virtual classrooms: Educational opportunity through two-way interactive television*. Lancaster, Pennsylvania: Technomic.
- Holzinger, A., Nischelwitzer, A. and Meisenberger, M. (2005). *Mobile phones as a challenge for m-learning*. Proceedings of the IEEE International Conference on Pervasive Computing and Communications, 2005, pp. 307-311.
- Horrigan, J. (2008). *Seeding The Cloud: What Mobile Access Means for Usage Patterns and Online Content*, Pew Internet & American Life Project. Retrieved on 4 April 2012 from http://pewinternet.org/pdfs/PIP_Users.and.Cloud.pdf.
- Howie, S. (2012). PIRLS 2011: South African Children's Reading Literacy Achievement Summary Report. Pretoria: Centre for Evaluation and Assessment, University of Pretoria.
- ICT update (2011). Highlights from TIMSS 2011. The South African Perspectives. Pretoria: Human Sciences Research Council (HSRC). Retrieved on 18 August 2013 from <http://www.google.com/search?client=ms...ICT+uate+2011.m>
- Humble-Thaden, M. B. (2012). *Tools for school: Student fluency and perception of cell phones used for learning*. Dissertation published by ProQuest LLC.
- Iddris, F. (2006). *Mobile advertising in B2C marketing*. Unpublished dissertation, Lulea University of Technology, Sweden. Internet world stats. (2011). Usage and population statistics. Retrieved on 12 June 2013 from <http://www.internetworldstats.com/>

- I.T.U. (2012). Statistics of the International Telecommunication Union: Measuring the Information Society 2011, p.166.
- Jarret, D. (1998). *Integrating Technology into Middle School Mathematics: It's Just Good Teaching*. North West Regional Educational Laboratory. Retrieved on 11 December 2010 from <http://www.nwrel.org/msec/book6.p.d.f>
- Jin, M., Feng, X., Liu, J. and Dai, F. (2010). Comparison study on high school students' mathematics belief systems between Han and Chaoxian nationality. *Journal of mathematics education*, 3(1), pp. 138-151.
- Johnson, C. and Kritsonis, W. A. (2007). National school debate: Banning cell phones on public school campuses in America. *National Forum of Educational Administration and Supervision Journals*, 25(4), pp. 1-6.
- Johnson, D. (2013). The tablet takeover. *Educational Leadership*, 70(5), pp. 78-79. Retrieved on 25 February 2011 from <http://www.ascd.org/publications/educationalleadership/feb13vol70/num05/The-Tablet-Takeover.aspx>
- Kafyulilo, A. (2012). Access, use and perceptions of teachers and students towards mobile phones as a tool for teaching and learning in Tanzania. Accessed on 31 October 2012 from <http://rd.springer.com/article/10.1007/s10639-012-9207-y>
- Kassarjian, H. H. and Robertson, T. S. (1991). *Perspectives in Consumer Behaviour* (4th edition). New Jersey: Prentice Hall.
- Kenning, M. (2007). *ICT and language learning: from print to the mobile phone*. New York: Palgrave Macmillan.
- Khwaileh, F. M. and Al-Jarrah, A. (2010). Graduate Students' Perceptions Toward Mobile-Learning (M-Learning) at the University of Jordan. *International Journal of Instructional Technology and Distance Learning*, 7(10), pp. 15-23.
- Kihwele, J. E. (2012). *A comparative study of parents', teachers' and students' perception on the effects of access to mobile phones on students' learning: a case of Dodoma Municipality*. Unpublished dissertation, University of Dodoma, Tanzania.

- Kim, D., Rueckert, D., Kim, D.-J. and Seo, D. (2013). Students' perceptions and experiences of mobile learning. *Language Learning & Technology*, 17(3), pp. 52-73. Retrieved on 4 May 2013 from <http://www.llt.msu.edu/issues/october2013/kimetal.pdf>
- Kim, S. H., Mims, C. and Holmes, K. P. (2006). An introduction to current trends and benefits of mobile wireless technology use in higher education. *Association for the Advancement of Computing in Education Journal*, 14(1), pp. 77-100.
- Kolb, L. (2008). *Toys to Tools: Connecting Students' Cell phones to Education*. International Society for Technology in Education. The International Society for Technology in Education (ISTE).
- Kollie, E. (2011). Mobile technology for the classroom. *School Planning & Management*, 50(1), pp. 80-82.
- Kukulska-Hulme, A. (2007). Mobile usability in educational contexts: What have we learnt? *International Review of Research in Open and Distance Learning*, 8(2).
- Leedy, P. D. and Ormrod, J. E. (2005). *Practical research: Planning and design* (8th ed.). Upper Saddle River, New Jersey: Pearson Education.
- Louw, W. (2015, January 6). www.equaleducation.org.za. Retrieved on 16 April 2015 from www.equaleducation.org.za/article/2015-01-07-on-the-2014-matric-results.
- Ma, Q. and Liu, L. (2004). The technology acceptance model: A metaanalysis of empirical findings. *Journal of Organizational and End User Computing*, 16(1), pp. 59-72.
- Mabilangan, R. A., Limjap, A. A. and Belecina, R. R. (2011). Problem solving strategies of high school students on non-routine problems: A case study. *Journal of basic education*, 5, pp. 23-46.
- Malhotra, N. K. and Birks, D. F. (2006). *Marketing research: An applied orientation* (2nd European ed.). Essex: Pearson Education Ltd.
- Maniar, N. (2007). M-learning to teach university students. In: C. Montgomerie and J. Seale (eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications*. Chesapeake, Virginia: AACE.

- Maniar, N., Bennett, E., Hand, S. and Allan, G. (2008). The effect of mobile phone screen size on video-based learning. *Journal of Software*, 3(4), pp. 51-61. Retrieved on 24 May 2010 from <http://ojs.academypublisher.com/index.php/jsw/article/view/03045161/974>
- Manzo, K. K. (2009). Online learning policy and practice survey: A survey of the states. *Education Week*, 29(13), p. 5.
- Marshall, T. (2008). A new approach to understanding the digital divide: Why two levels are not enough. *Conversants*, 1.
- Masero, S. J. (2008). Las TIC(s) en el currículo de la enseñanza obligatoria en el área de Educación Física en España. *Lecturas: educación Física Deportes*, 121 Retrieved on 10 November 2012 from <http://www.efdeportes.com>
- McDaniel, R. (2012). *How can a smart board be beneficial to students' learning?* EHow Family. Retrieved on 15 May 2011 from http://www.ehow.com/about_6635274_can-beneficial-students-learning-.html
- McFarlane, A., Ruthven, K. and Winterbottom, M. (2007). Pedagogical approaches for technology-integrated science teaching. *Computers and Education* 48, pp. 137-152.
- McMahon, M. and Pospisil, R. (2005). *Laptops for a digital lifestyle: the role of ubiquitous mobile technology in supporting the needs of millennial learners*. Paper presented at Educause Australasia 2005, the next wave of collaboration, Auckland.
- McMillan, J. H. and Schumacher, S. (2010). *Research in education: Evidence Based Inquiry* (7th ed.). New York: Pearson.
- McMillan, J. H. (2007). *Education Research: Fundamentals for the Consumer* (5th Edition). New York: Longman, Inc.
- Mellow, P. (2005, December). *The media generation: maximize learning by getting mobile*. Paper presented at Ascilite 2005. Retrieved 25 October 2012 from http://www.ascilite.org.au/conferences/brisbane05/blogs/proceedings/53_Mellow.pdf
- Merriam, S. B. (2009). *Qualitative Research: A Guide to Design and Implementation*. New Jersey: Jossey-Bass.

- Milner, K. and Khoza, H. (2008). Mobile technology for better teaching South Africans. *South African Journal of Education*, 28(3). Info (2011). Retrieved on 8 June 2012 from <http://www.southafrica.info/about/education/vodamobile-241011>
- Milrad, M. and Spikol, D. (2007). *Integrating co-design practices into the development of mobile science collaboratories*. Stanford, California: Stanford Centre for Innovations in Learning.
- Mitra, A., Lenzmeier, S., Steffensmeier, T., Avon, R., Qu, N. and Hazen M. (2005). MobiLearn Project. Retrieved on 31 May 2010 from <http://www.mobilelearn.org>
- Montgomery, K. (2009). *Generation digital: Politics, commerce, and childhood in the age of the Internet*. Cambridge, Massachusetts: The MIT Press.
- Mouton, J. (1996). *Understanding social research*. Pretoria: J. L. van Schaik Publishers.
- Mtega, W. P., Bernard, R., Msungu, A. C. and Sanare, R. (2012). Using mobile phones for teaching and learning purposes in higher learning institutions: the case of Sokoine University of Agriculture in Tanzania. ISSN 2223-7062: *Proceedings and Report of the 5th UbuntuNet Alliance annual conference 2012*. Sokoine University of Agriculture, Tanzania.
- Mwirira, K. and Wamahiu, S. (1995). *Issues in educational research in Africa*. Nairobi, East Africa: Educational Books.
- Naidoo, D. (2004). *Linking the utilization of research findings to research in MST education*. Paper presented at the 12th Annual Conference of the Southern African Association for Research in Mathematics, Science and Technology Education, University of Cape Town.
- Netsu, R. (2006). Cellular phone technology in the classroom. *Asia University Journal Online*, 14(5), pp. 27-31. Retrieved from http://www.asiaau.ac.jp/cele/cele_CELE%Journal%2006%Vol%2014/005Cell%20
- Ngulube, P. (2013). Mixed methods research designs. *College of Education, mixed methods research design workshop*. University of South Africa, Pretoria.
- Nokia Conversations. (2012). Mixing learning and mobile to get education for all the official blog. Retrieved from <http://www.nokia.com/2010/10/26/mixing-learning-and-mobile-to-get-education-for-all/UNESCO>

- Nyiri, K. (2002). *Towards a philosophy of mlearning*. Paper presented at the IEEE International Workshop on Wireless and Mobile Technologies in Education, Vaxjo, Sweden.
- Oblinger, D. G., and Oblinger, J. I. (2005) Educating the net generation. *Educause*. Retrieved on 9 March 2012 from <http://www.educause.edu/educationthenetgen/>
- Obringer, J. S. and Coffey, K. (2007). Cell phones in American high schools: A national survey. *The Journal of Technology Studies*, 33(1), pp. 41-47.
- O'Malley, C., Vavoula, G., Glew, J. P., Taylor, J. and Sharples, M. (2005). *Guidelines for Learning/Teaching/Tutoring in a Mobile Environment*. Retrieved on 7 July, 2009 http://www.mobilelearn.org/download/results/public_deliverables/MOBILearn_D4.1_Final.pdf
- Palfrey, J. and Glasser, U. (2008). *Born Digital: Understanding the first generation of digital natives*. New York, NY: Basic Books.
- Patton, M. Q. (2002). *Qualitative Research and Evaluation Methods* (3rd ed.). Thousand Oaks, California: Sage.
- Paul, R. H. (1995). *Virtual Reality or Fantasies. Technology and the Future*, cited in: J. Roberts and E. Keough (eds.), *Why the Information Highway? Lessons from Open and Distance Learning*, pp. 126-145. Toronto: Trifolium Books.
- Perry, D. (2003). *Handheld computers (PDAs) in schools*. Retrieved on 27 March 2012 from http://www.becta.or.uk/corporate/press_out.cfm?id=2636
- Politics web. (2012). *Sacci: Matric pass rate won't aid economy*. Fin24. Retrieved on 13 April 2012 from www.fin24.com/economy/sacci.matric.www.politicsweb.co.za
- Pollara, P. and Broussard, K. K. (2011). *Student Perceptions of Mobile Learning: A Review of Current Research*. Society for Information Technology & Teacher Education International Conference.
- Prensky, M. (2013). Our brain extended. *Educational Leadership*, 70(6), pp. 23-27.
- Prensky, M. (2001) Digital Natives, Digital Immigrants, On The Horizon. *NCB University Press*, 9(5).

- Prensky, M. (2010). *What I learned recently in New York classrooms: How to keep all kids busily engaged at all times*. Retrieved on 8 November 2010 from http://www.marcprensky.com/writing/Prenskythat_ILearned_in_NYC_Classrooms-final.pdf
- Project Tomorrow. (2010). *Creating our future: Students speak up about their vision for 21st century learning*. Retrieved on 10 June 2011 from <http://tomorrow.org/speakup/pdfs/SU09National>
- Quinn, C. (2000). *mLearning: Mobile, Wireless and In-Your-Pocket Learning*. Retrieved on 12 October 2010 from Line Zine Magazine: www.linezine.com/2.1/features/cqmmwiyp.htm
- Quitadamo, I. J. and Brown, A. (2001). *Effective teaching styles and instructional design for online learning environments*. National Educational Computing Conference (Chicago, IL). http://confreg.uoregon.edu/NECC2001/program/research_pdf/Quitadamo.pdf
- .
- Reddy, V., Kanjee, A., Diedericks, G. and Winnaar, L. (2006). *Mathematics and science achievement at South African schools in TIMSS 2003*. Cape Town: HSRC Press.
- Rismark, M., Sølvsberg, A. M., Strømme, A. and Hokstad, L. M. (2007). Using Mobile Phones to Prepare for University Lectures: Students' Experiences. *The Turkish Online Journal of Educational Technology*, 6(4). Retrieved on 11 November 2008 from <http://www.tojet.net/articles/649.htm>
- Roberts, N. and Butcher, N. (2011). *Evaluation of Nokia Momaths 2010: Report on update use and impact on results January-December 2010*. Neil Butcher and Associates.
- Roberts, T. G., Iran, T. A., Telg, W. and Lundy, L. K. (2005). The development of an instrument to evaluate distance education courses using students' attitudes. *The American journal of distance education*, 19(1)
- Rogers, Y., Connelly, K., Hazlewood, W. and Tedesco, L. (2010). Enhancing learning: a study of how mobile devices can facilitate sense making. *Personal & Ubiquitous Computing*, 14(2), pp. 111-124.

- Roos, G. (2002). Establishing online communities of educators and learners: Putting our virtual head together, p.3. Netnews Thintana school internet project, p.1. Johannesburg: School net SA. Retrieved on 6 May 2012 from <http://www.school.za>
- Roschelle, J., Patton, C. and Tatar, D. (2007). Designing networked handheld devices to enhance school learning. In: M. Zelkowitz (ed.), *Advances in Computers*, 70, pp. 1-60.[viewed on 27 October 2013] <http://www.citl.sri.com/publications/downloads/AdvancesComputes70.pdf>
- Rosenberg, M. J. (2001). *E-Learning: Strategies for delivering knowledge in the digital age*. New York, NY: McGraw-Hill.
- Sandholtz, J. H., Ringstaff, C. and Dwyer, D. C. (1997). *Teaching with technology*. New York, NY: Teachers' College, Columbia University.
- Saunders, M. N., Lewis, P. and Thornhill, A. (2009). *Research Methods for Business Students* (5th ed.). Essex, UK: Pearson.
- Scardamalia, M. and Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In: K. Sawyer (ed.), *Cambridge handbook of the learning sciences*. New York: Cambridge University Press. Retrieved from http://ikit.org/fulltext/2006_KBTheory.pdf
- Seale, C. (1998). *Researching Society and Culture*. London. Sage Publications.
- Selvaratnam, M. (2011). Competence of matric physical sciences teachers in some basic problem-solving strategies. *South African Journal of Science*, 107(1/2). DOI:10.4102/sajv107i1/2.262.
- Sendecka, L. (2006). *Adoption of mobile services. Moderating effects of service's information intensity*. Unpublished dissertation, Norges Handelshøyskole, Bergen, Norway.
- Sheppard, B. H., Hartwick, J. and Warshaw, P. R. (1988). The theory of reasoned action: A meta-analysis of past research with recommendations for modifications and future research. *The Journal of Consumer Research*, 15(3), pp. 325-343.
- Shuler, C. (2009). *Pockets of potential: Using mobile technology to promote children's learning*. Retrieved on 22 February 2013 from <http://joanganzcooneycentre.org/Reports-23.html>

- Shuttleworth, M. and volunteers. (2011). *Everything Science. Grade, 10; 11 and 12 Physical Sciences*. Available at <http://www.everythingscience.co.za>
- Shuttleworth, M. (2009). *Convergent and discriminant validity*. Retrieved on 23 July 2012 from <http://www.experiment-resources.com/convergent-validity.html>
- Silander, P., Sutinen, E. and Tarhio, J. (2004). Mobile Collaborative Concept Mapping – Combining Classroom Activity as with Simultaneous Field Exploration. *Proceedings of the 2nd IEEE International Workshop on Wireless and Mobile Technologies In Education, WMTE 2004*, pp. 114-118.
- Siraj, S. (2005). *M-learning dalam pembangunan sekolah berteknologi diMalaysia: Prospekpelaksanaan. (M-learning in the development for schools with technology in Malaysia: Implementation prospects)*. Paper presented at National Seminar on ICT in Education, Tanjung Malim, 17-19 November 2005.
- Smith, A. and Holian, R. (1999). *The credibility of the researcher who does research in their own organisation*. Paper presented at the Association for Qualitative Research conference: Issues of Rigour in Qualitative Research. Melbourne.
- South Africa-Finland Partnership (SAFIPA). (2012). Mobile learning for mathematics in formal/informal education in South Africa. Retrieved on 8 April 2010 from www.slideshare.net/SAFIPA/mobile-learning-for-mathematics-in-formal-informal-education-in-South-Africa-finland-ritta-vanska
- Stead, G., Sharpe, B., Anderson, P., Cych, L. and Philpott, M. (2006). *Emerging technologies for learning*. Coventry, UK: Becta.
- Swan, K., van 'tHooft, M., Kratcoski, A. and S. Chenker, J. (2007). Ubiquitous computing and changing pedagogical possibilities: Representations, conceptualizations and uses of knowledge. *Journal of Educational Computing Research*, 36, pp. 481-515.
- Swarts, P. and Wachira, E. M. (2010). *Tanzania: ICT in Education Situational Analysis*. Global E-School and Communities Initiative.
- Tapscott, D. (2009). *Grown up digital*. New York, NY: McGraw-Hill.
- Taylor, N. (2008). *What's wrong in South African Schools?* Presentation to the conference on *What's Working in School Development?* JET Education Services, 28-29 February 2008.
- Taylor, S. and Todd, P. A. (1995). Understanding information technology usage: A test of competing models. *Information Systems Research*, 6(2), pp. 144-176.

- The New Media Consortium and the Educause Learning Initiative. (2008). *The Horizon Report 2008*. Retrieved on 3 November 2009 from <http://www.nmc.org/pdf/2008-Horizon-Report.pdf>
- Thornton, P. and Houser, C. (2005). Using Mobile Phones in English Education in Japan. *Journal of Computer Assisted Learning*, 21, pp. 217-228. Available at <http://dx.doi.org/10.1111/j.1365-2729.2005.00129.x>
- Ting, R. Y. L. (2007). The Advanced Mobile Learning Practices: Learning Features and Implications. In: *Proceedings of Advanced Learning Technologies, ICALT 2007. Seventh IEEE International Conference*, pp. 718-720. <http://ieeexplore.ieee.org/iel5/4280926/4280927/04281137.pdf?tp=&isnumber=&arnumber=4281137>
- Traxler, J. (2005). *Defining Mobile Learning*. IADIS International Conference on Mobile Learning.
- Traxler, J. (2010). *Education and the Impact of Mobiles and Mobility: An Introduction to Mobiles in our Societies* [online]. Retrieved on 15 October 2011 from [http://wlv.academia.edu/JohnTraxler/Papers/130453/Education and the Impact of Mobiles and Mobility](http://wlv.academia.edu/JohnTraxler/Papers/130453/Education_and_the_Impact_of_Mobiles_and_Mobility)
- Trochim, W. M. K. (2006) *Convergent and discriminant validity*. Retrieved on 25 March 2011 from <http://www.socialresearchmethods.net/kb/convdisc.php>
- Turuen, H., Syvänen, A. and Ahonen, M. (2001). Supporting Observation Tasks in a Primary School with the Help of Mobile Devices. In: Nyíri, K. (ed.) *Mobile Learning: Essays on Philosophy, Psychology and Education*, pp. 209-221. Vienna: Passagen Verlag.
- UNESCO. (2012). *Exploring the potential of mobile technologies to support educators and improve practice*. UNESCO Working paper series on mobile learning. Retrieved on 10 December 2012 from <http://www.unesco.org/new/en/unesco/themes/icts/m4ed/>
- UNESCO/UNICEF. (2005). Monitoring Learning Achievement Project.
- Van Biljon, J. A. (2006). *A model for representing the motivational and cultural factors that influence mobile phone usage variety*. Unpublished dissertation, University of South Africa.
- Vanska, R. and Robertson, N. (2011). Mobile learning for Mathematics (Nokia Momaths) Project in South Africa and Finland – United Nations ECOSOC Innovation Fair. www.literacyonline.org/explorer/un_back.html

- Vatanparast, R. (2009). Theories Behind Mobile Technology Acceptance and Service Adoption. In: *Handbook of Research in Mobile Marketing Management*, ISBN: 978-1-60566-074-5, Business Science Reference.
- Venkatesh, B., Nargundkar, R., Sayed, F. K. and Shahaida, P. (2006). Assessing Indian students' perceptions towards m-Learning – some initial conclusions. *International Journal of Mobile Marketing*, 1(2), pp. 75-79.
- Venkatesh, V. and Davis, F. D. (2000). A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science*, 46(2), pp. 186-204.
- Venkatesh, V., Morris, M. G., Davis, G. B. and Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), pp. 425-478.
- Vodamobile. (2011). Mobile technology for better teaching. Retrieved 20 March 2012 from www.southafrica.info/about/education/vodamobile-241011.htm
- Wagner, T. (2008). *The global achievement gap*. New York, NY: Basic Books.
- Walton, M. (2009). Mobile literacies & South African teens: Leisure reading, writing, and MXit chatting for teens in Langa and Guguletu. CapeTown:Shuttleworth Foundation. Retrieved on 25 April 2010 from http://m4lit.files.wordpress.com/2010/03/m4lit_mobile_literacies_mwalton20101.pdf
- Wang, F., Chen, X. and Fang, W. (2011). Integrating cell phones into a Chinese high school EFL classroom: Students' attitudes, technological readiness, and perceived learning. *Journal of Educational Technology, Development and Exchange*, 4(1), pp. 91-102.
- Wang, M., Shen, R., Novak, D. and Pan, X. (2009). The impact of mobile learning on students' learning behaviours and performance: Report from a large blended classroom. *British Journal of Educational Technology*, 40(4), pp. 673-695.
- Wang, Y. S. and Shih, Y.-W. (2008). Why do people use information kiosks? A validation of the Unified Theory of Acceptance and Use of Technology. *Government Information Quarterly*, 26(1), pp. 158-165, Switzerland 2011. Retrieved on 15 December 2013 from www.weForum.org/reports/annual-report

- Wentzel, P., van Lammeren, R., Molendijk, M., de Bruin, S. and Wagtendonk, A. (2005). Using mobile technology to enhance students' educational experiences. ECAR Case Study 2, *Educause Quarterly*, pp. 1-18.
- Wiersma, W. and Jurs, S. G. (2008). *Research Methods in Education: An Introduction*. (9th Edition). Itasca, Illinois: F. E. Peacock Publishers, Inc
- Wiley, D. (2002). *The Reusability Paradox*. Retrieved on 12 October 2012 from [http://rclt.usu.edu/whitepapers/paradox.html#internal %20context](http://rclt.usu.edu/whitepapers/paradox.html#internal%20context)
- Williams, P. W. (2009). *Assessing mobile learning effectiveness and acceptance*. Unpublished dissertation, George Washington University. Washington DC.
- Willoughby, T. (2008). A short-term longitudinal study of internet and computer game use by adolescent boys and girls: Prevalence, frequency of use, and psychosocial predictors. *Psychology*, 44(1), pp. 195-204. DOI: 10.1037/0012-1649.44.1.195
- World Economic Forum (WEF). (2011). *The global competitiveness report 2011-2012*. World Economic Forum, Geneva.
- Young, D. (2012). *Teachers' perceived barriers to technology integration as prescribed by the 21st century learning skills*. Doctoral thesis, Walden University, Minneapolis, Minnesota, www.scholarworks.waldenu.edu/dissertations/
- Young, J. (2011, February). *Next-generation learning technologies: Catalyst for education reform?* Presented to the Florid Educational Technology Conference. Orlando, Florida.

APPENDIX I

LETTER TO THE DEPARTMENT OF EDUCATION REQUESTING PERMISSION TO CONDUCT RESEARCH

Request for permission to conduct research in Moretele high schools

26 September 2014

Mrs M. K. Z. Mosala

Area Manager

Moretele Area Office

Department of Education

Private Bag X 365

Makapanstad

0404

tel: (12) 7143906 fax: (12) 7143912

Dear Mrs Mosala

I am doing research for my M. Ed. under the supervision of Professor N. Nkopodi, Professor of Education at the University of South Africa. We are inviting you to participate in a study entitled *Learners' and educators' perceptions of the use of cell phones in the teaching of Physical Sciences in Moretele high schools of the Bojanala district*.

I am conducting this study to examine the perceptions of learners and educators of the use of cell phones with internet services in the teaching and learning of Physical Sciences.

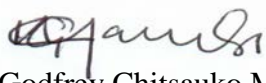
Your high schools have been selected because they are using cell phones with internet services in the teaching and learning of Physical Sciences.

The study will entail data collection using questionnaires, focus groups and interview schedules. Grade 10, 11 and 12 Physical Sciences learners and their educators will be the participants. The educators and the learners will be asked to complete a consent

form or have an assent form signed by their parent or guardian. All participants will be volunteers who participate willingly and are free to withdraw at any time without giving reasons. No punishment will be given for withdrawal. There are no risks or rewards involved in this research. Questionnaires will precede interviews. The interviews will be done as follow-ups on data collected through the questionnaires. The aim of this study is for its results to raise important insights as to the applicability of incorporating modern mobile technologies into the teaching and learning of Physical Sciences.

Feedback procedure will include emailing findings to interested participants upon request.

Yours sincerely

A handwritten signature in dark ink, appearing to read 'Godfrey Chitsauko Muyambi', written in a cursive style.

Godfrey Chitsauko Muyambi

Researcher

APPENDIX II

LETTER TO PRINCIPALS OF SCHOOLS REQUESTING PERMISSION TO CONDUCT RESEARCH

Request for permission to conduct research in your school

26 September 2014

The Principal

(Details of school)

Dear Sir/Madam

I am doing research for my M. Ed. under the supervision of Professor N. Nkopodi, Professor of Education at the University of South Africa. We are inviting you to participate in a study entitled *Learners' and educators' perceptions of the use of cell phones in the teaching of Physical Sciences in Moretele high schools of the Bojanala district*.

I am conducting this study to examine the perceptions of learners and educators regarding the use of cell phones with internet services in the teaching and learning of Physical Sciences.

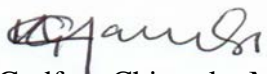
Your high school has been selected because its educators and senior learners are using cell phones with internet services in the teaching and learning of Physical Sciences.

The study will entail data collection using questionnaires, focus groups and interview schedules. Grade 10, 11 and 12 Physical Sciences learners and their educators will be the participants. The educators and the learners will be asked to complete a consent form or have an assent form signed by their parent or guardian. All participants will be volunteers who participate willingly and are free to withdraw at any time without giving reasons. No punishment will be given for withdrawal. There are no risks or rewards involved in this research. Questionnaires will precede interviews. The interviews will be done as follow-ups on data collected through the questionnaires.

The aim of this study is for its results to raise important insights as to the applicability of incorporating modern mobile technologies into the teaching and learning of Physical Sciences.

Feedback procedure will include emailing findings to interested participants upon request.

Yours sincerely

A handwritten signature in dark ink, appearing to read 'Godfrey Chitsauko Muyambi', written in a cursive style.

Godfrey Chitsauko Muyambi

Researcher

APPENDIX III

LETTER TO PROSPECTIVE PARTICIPANTS

26 September 2014

Dear Prospective Participant

My name is Godfrey Chitsauko Muyambi and I am doing research for my M. Ed. in Natural Science under the supervision of Professor N. Nkopodi, Professor of Education at the University of South Africa. We are inviting you to participate in a study entitled *Learners' and educators' perceptions of the use of cell phones in the teaching of Physical Sciences in Moretele high schools of the Bojanala district*.

What is the aim or purpose of the study?

I am conducting this research to find out about the perceptions of educators and learners regarding the use of cell phones with internet services in the teaching and learning of Physical Sciences.

Why am I being invited to participate?

You have been selected to participate in the research because you are directly involved in the use of cell phones with internet services in the teaching and learning of Physical Sciences. Your knowledge of and experience in using cell phones with internet services for teaching and learning Physical Sciences will be valuable. I learned of your school's use of cell phones at a Dinaledi schools workshop that I attended on 23 March 2011 in Rustenburg. There will be 345 learners and nine educators who will be chosen to participate in the study, partly at random and partly by selection.

What is the nature of my participation in this study and what does the research involve?

Your role in the study will be to respond to a questionnaire and take part in a focus-group or a face-to-face interview.

The study involves questionnaires, focus groups and structured interviews. It will take approximately 30 minutes to answer the questionnaires and 15 minutes to complete the interviews.

Can I withdraw from this study?

Participation is voluntary and there is no penalty or loss of benefit for non-participation.

Your taking part in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason. However, it will not be possible to withdraw once data have been collected and recorded.

What are the potential benefits of taking part in this study?

Taking part in this project does not involve any rewards except that it is hoped that the findings of the study will raise important insights as to the applicability of incorporating cell-phone technologies into the teaching and learning of Physical Sciences. The information collected will be used entirely for academic purposes.

What is the anticipated inconvenience of taking part in this study?

This study will use part of your study periods but it does not involve any risks.

Will what I say be kept confidential?

Your name will not be recorded anywhere and no-one will be able to connect you to the answers you give. Your answers will be given a fictitious code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder and members of the Research Ethics Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.

Focus groups involve consensus answers of the participants. People in a focus group discuss their responses and agree before giving them.

While every effort will be made to ensure that you will not be connected to the information that you share during the focus group, I cannot guarantee that other participants in the focus group will treat information confidentially, though I shall encourage all participants to do so. *For this reason I advise you not to disclose personally sensitive information in the focus group.*

How will information be stored and ultimately destroyed?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard or filing cabinet in the UNISA library for future research or academic purposes; electronic information will be stored on a password-protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. At the end of five years information stored as hard copies will be burnt and that stored as soft copies will be erased.

Will I receive payment or any incentives for participating in this study?

There will be no rewards offered and also there are no costs that you are going to incur.

Has the study received ethics approval?

This study has received written approval from the Research Ethics Committee of the College of Education, UNISA. A copy of the approval letter can be obtained from the researcher if you so wish.

How will I be informed of the findings or results?

If you would like to be informed of the final research findings, please contact me on 0738138203 or email 45362688@mylife.unisa.ac.za. The findings are accessible for a period of three months.

Should you have concerns about the way in which the research has been conducted, you may contact Prof. N. Nkopodi at 0828554384 or email nkopon@unisa.ac.za. Alternatively, contact the research ethics chairperson, Dr Madaleen Claassens, at mcdtc@netactie.co.za.

Thank you for taking the time to read this information sheet and for participating in this study.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Godfrey C. Muyambi', written on a light blue background.

Godfrey C. Muyambi
Researcher

Date:

APPENDIX IV
CONSENT TO PARTICIPATE IN THE STUDY

I, _____ (participant's name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty.

I am aware that the findings of this study will be anonymously processed into a research report, journal publications and/or conference proceedings.

I agree to the recording of the questionnaire and interviews.

I have been assured that I will receive a signed copy of the informed consent agreement.

Name & surname of participant (please print)
of researcher (please print)

Name & surname

Signature of participant

Signature of researcher

Date:

Date:

APPENDIX V

LETTER REQUESTING PARENTAL CONSENT FOR PARTICIPATION OF A MINOR IN THE RESEARCH PROJECT

Dear Parent/Guardian

Your child is invited to participate in a study entitled *Learners' and educators' perceptions of the use of cell phones in the teaching and learning of Physical Sciences in Moretele high schools of the Bojanala district*. I am undertaking this study as part of my M. Ed. research at the University of South Africa. The purpose of the study is to find out the views of learners and educators on their use of cell phones with internet services in the teaching and learning of Physical Sciences. The possible benefit of the study is the improvement of teaching and learning of Physical Sciences in the schools through the use of cell phones. I am asking permission to include your child in this study because the learner is directly involved in using cell phones in the teaching and learning of Physical Sciences. I expect to have a total of three hundred and forty-four (344) other learners participating in the study.

If you allow your child to participate, I shall request him or her to:

- Answer a questionnaire
- Take part in a group interviews

Any information that is obtained in connection with this study and can be identified with your child will remain confidential and will be disclosed only with your permission. His or her responses will not be linked to his or her name or your name or the school's name in any written or verbal report based on this study. Such a report will be used for research purposes only.

There are no foreseeable risks to your child in participating in the study. Your child will receive no direct benefit from participating in the study; however, the possible benefit to education is the improvement of teaching and learning through the use of

cell phones with internet services. Neither your child nor you will receive any type of payment for participating in this study.

Your child's participation in this study is voluntary. Your child may decline to participate or withdraw from participation at any time. Withdrawal or refusal to participate will not affect him or her in any way. Similarly, you can agree to allow your child to be in the study now and change your mind later without any penalty.

The study will take place during regular classroom activities with the prior approval of the school and your child's teacher. However, if you do not want your child to participate an alternative activity will be available.

In addition to your permission, your child must agree to participate in the study and you and your child will also be asked to sign the assent form which accompanies this letter. If your child does not wish to participate in the study, he or she will not be included and there will be no penalty. The information gathered from the study and your child's participation in the study will be stored securely on a password-locked computer at the UNISA library for five years after the study. Thereafter, records will be erased.

If you have questions about this study please ask me or my study supervisor, Prof. N. Nkopodi of the Department of Education, University of South Africa. My contact number is 0738138203 and my email is 45362688@mylife.unisa.ac.za. The email of my supervisor is nkopon@unisa.ac.za. Permission for the study has already been given by Dr Madaleen Claassens and the Ethics Committee of the College of Education, UNISA, which she chairs.

You are making a decision about allowing your child to participate in this study. Your signature below indicates that you have read the information provided above and have decided to allow him or her to participate in the study. You may keep a copy of this letter.

Name of child (please print)

Name of parent/guardian (please print)
print)

Date:

Signature of parent/guardian (please

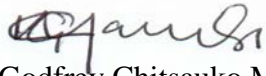
Name of researcher (please print)

Date:

Signature of researcher (please print)

Thank you for your attention and response.

Yours sincerely

A handwritten signature in dark ink, appearing to read 'Godfrey Chitsauko Muyambi', written over a light blue rectangular background.

Godfrey Chitsauko Muyambi

Researcher

APPENDIX VI

LETTER REQUESTING LEARNER'S ASSENT TO PARTICIPATE IN THE RESEARCH PROJECT

Title of study: *Learners' and educators' perceptions of the use of cell phones in the teaching and learning of Physical Sciences in Moretele high schools of the Bojanala district.*

Dear Learner

My name is Godfrey Muyambi and I am doing a study on learners' and educators' perceptions of the use of cell phones with internet services in the teaching and learning of Physical Sciences as part of my studies at the University of South Africa. Your principal has given me permission to do this study in your school. I would like to invite you to be a very special part of my study. I am doing this study so that I can find ways that you and your Physical Sciences teachers can use to improve the use of cell phones with internet services in the teaching and learning of Physical Sciences. This will help you and many other learners of your age in different schools.

This letter is to explain to you what I would like you to do. There may be some words you do not know in this letter. You may ask me or any other adult to explain any of these words that you do not know or understand. You may take a copy of this letter home to think about my invitation and talk to your parents about this before you decide if you want to be in this study.

The study will ask you to answer questions from a questionnaire and take part in a focus-group interview. Completing the questionnaire will take you a maximum of 30 minutes and the focus-group interview will take about 15 minutes. The questions will be on the use of cell phones with internet services in the teaching and learning of Physical Sciences. Your name will not appear on the questionnaire or recording sheet and the responses will not count for any marks at school. I will record your responses using pseudo-names or codes and I will not share your answers with any other learner, teacher or parent.

I will write a report on the study but I will not use your name in the report or say anything that will let other people know who you are. You do not have to be part of this study if you don't want to take part. If you choose to be in the study, you may stop taking part at any time. You may tell me if you do not wish to answer any of my questions. No one will blame or criticise you. When I am finished with my study, I shall return to your school to give a short talk about some of the helpful and interesting things I found out in my study. I shall invite you to come and listen to my talk.

If you decide to be part of my study, you will be asked to sign the form on the next page. If you have any questions about this study, you can talk to me or you can have your parent or another adult call me at 0738138203. Do not sign the form until you have all your questions answered and understand what I would like you to do.

Researcher: Godfrey C. Muyambi Phone number: 0738138203

Do not sign this form if you have any questions. Ask your questions first and ensure that someone answers those questions.

WRITTEN CONSENT

I have read this letter, which asks me to be part of a study at my school. I have understood the information about my study and I know what I will be asked to do. I am willing to be in the study.

Learner's name (please print) Learner's signature Date:

Witness's name (please print) Witness's signature Date:

(The witness is over 18 years old and present when signed.)

Parent/guardian's name (please print) Parent/guardian's signature

Date:

Researcher's name (please print) Researcher's signature

Date:

APPENDIX VII
LETTER REQUESTING EDUCATOR TO PARTICIPATE IN AN
INTERVIEW

Dear Educator

This letter is an invitation to consider participating in a study I am conducting as part of my research as an M. Ed. student at the University of South Africa. The title of the study is *Learners' and educators' perceptions of the use of cell phones in the teaching and learning of Physical Sciences in Moretele high schools of the Bojanala district*. Permission for the study has been given by Dr Madaleen Claassens and the Ethics Committee of the College of Education, UNISA, which she chairs. I have identified you as a possible participant because of your valuable experience and expertise in my research topic.

I would like to provide you with more information about this project and what your involvement would entail if you should agree to take part. Cell phones with internet services have now become part of teaching and learning tools. I would therefore like to have your views on the use of cell phones with internet services in the teaching and learning of Physical Sciences. I would ask you questions and invite your comments on the use of cell phones with internet services in the teaching and learning of Physical Sciences. The findings of this study will possibly help to improve teaching and learning via the use of cell phones in Physical Sciences.

Your participation in this study is voluntary. It will involve a face-to-face interview of approximately 15 minutes, to take place in a mutually agreed location at a time convenient to you. You may decline to answer any of the interview questions if you so wish. Furthermore, you may decide to withdraw from this study at any time without any negative consequences.

With your kind permission, the interview will be audio-recorded to facilitate collection of accurate information and later transcribed for analysis. Shortly after the transcription has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of its record of our conversation and to add or

clarify any points that you wish. All information you provide is considered completely confidential. Your name will not appear in any publication resulting from this study and any identifying information will be omitted from the report. However, with your permission, anonymous quotations may be used. Data collected during this study will be retained on a password-protected computer for twelve months in my locked office. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at 073 8138203 or by email at 45362688@mylife.unisa.ac.za.

I look forward very much to speaking with you and thank you in advance for your assistance in this project. If you accept my invitation to participate, please sign the consent form on the page.

Yours sincerely



Godfrey C. Muyambi.

CONSENT FORM

I have read the information presented in the information letter about the study to be carried out on learners' and educators' perceptions of the use of cell phones with internet services in the teaching and learning of Physical Sciences. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and to find out about any additional details I wanted. I am aware that I have the option of allowing my interview to be audio-recorded to ensure an accurate recording of my responses. I am also aware that excerpts from the interview may be included in publications to come from this research, with the understanding that the quotations will be anonymous. I have been informed that I may withdraw my consent

at any time without penalty by advising the researcher. With full knowledge of all the foregoing, I agree, of my own free will, to participate in this study.

Participant's name (please print):

Participant's signature:

Researcher's name (please print):

Researcher's signature:

Date:

APPENDIX VIII

COVERING LETTER FOR LEARNERS' QUESTIONNAIRE

Title of questionnaire: *Learners' perceptions of the use of cell phones in the teaching and learning of Physical Sciences.*

Dear Respondent

This questionnaire forms part of my research study, entitled *Learners' and educators' perceptions of the use of cell phones in the teaching and learning of Physical Sciences in Moretele high schools of the Bojanala district*, for the degree of M. Ed. at the University of South Africa. You have been selected by a purposive sampling strategy from the population of Physical Sciences learners based on your use of cell phones with internet services for learning Physical Sciences. Hence, I invite you to take part in this survey.

The aim of this study is to investigate learners' and educators' perceptions of the use of cell phones with internet services in the teaching and learning of Physical Sciences. The findings of the study will benefit both learners and educators in coming up with the best ways to use cell phones with internet services in the teaching and learning of Physical Sciences.

You are kindly requested to complete this survey questionnaire, consisting of section A and section B, as honestly and frankly as possible and according to your personal views and experience. No foreseeable risks are associated with the completion of the questionnaire, which is for research purposes only. The questionnaire will take approximately 30 minutes to complete.

You are not required to indicate your name and your anonymity will be ensured; however, indication of your age and gender will contribute to a more comprehensive analysis. All information obtained from this questionnaire will be used for research purposes only and will remain confidential. Your participation in this survey is voluntary and you have the right to omit any question if so desired, or to withdraw from answering this survey without penalty at any stage. After the completion of the

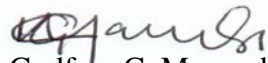
study, an electronic summary of the findings of the research will be made available to you on request.

Permission to undertake this survey has been granted by the University of South Africa and the Ethics Committee of the College of Education, UNISA. If you have any research-related enquiries, they can be addressed directly to me or my supervisor, Professor N. Nkopodi of the Department of Education, UNISA. My contact details are 0738138203 and email 45362688@mylife.unisa.ac.za, and his are 0828554384 and email nkopon@unisa.ac.za.

By completing the questionnaire you imply that you have agreed to participate in this research.

Please return the completed questionnaire to the assistant researcher at your school.
Thank you.

Yours sincerely



Godfrey C. Muyambi

Researcher

APPENDIX IX
QUESTIONNAIRE FOR LEARNERS

Section A

Instructions

- a) Do not write your name or name of school on the questionnaire.
- b) Please put a tick in the box provided to indicate your response to each question.
- c) You are kindly asked to answer all the questions.
- d) Note there are no correct or wrong answers to this questionnaire. However, your opinion is

- 1. What is your gender? 1. Female ☐ 2. Male ☐
- 2. What is your age? ☐
- 3. Do you have a cell phone with internet services?
1. Yes ☐ 2. No ☐
- 4. Do you use your cell phone with internet services for Physical Sciences learning?
1. Yes ☐ 2. No ☐
- 6. If “Yes”, how many times in a week do you use a cell phone with internet services for Physical Sciences learning?
1. 1-2 times ☐ 2. 3-4 times ☐
3. 5 or more times ☐
- 7. How many times in a week do you receive SMS comments from your teacher?
1. 1-2 times ☐ 2. 3-4 times ☐ 3. 5 or more times ☐
4. Not at all ☐

1. Do you think a mobile Physical Sciences programme helps you to pass Physical Sciences?

1. Yes ☐ 2. No ☐ 3. Not sure ☐

8. If “Yes”, give your reasons. -----

9. What I like most about cell phones with internet services in Physical Sciences learning is [choose one answer only]:

1. Cell-phone Physical Sciences exercises and experiments are easy to understand. ☐

2. A cell-phone Physical Sciences programme gives quick feedback on exercises and tests. ☐ ☐

3. I can compare my performance with that of other learners. ☐

4. Mobile sciences use audio-visual aids. ☐

5. All of the above. ☐

10. Do you think cell phones with internet services should be used for Physical Sciences learning in all schools?

1. Yes ☐ 2. No ☐ 3. Not sure ☐

11. If “Yes”, give your reasons. -----

Section B

Listed below are statements that require your opinion on mobile Physical Sciences.

Please answer by ticking either 1, 2, 3, 4 or 5 to indicate your choice.

1=Strongly disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly agree.

	Question	Strongly agree [5]	Agree [4]	Undecided [3]	Disagree [2]	Strongly disagree [1]
1	I have a good knowledge of the use of a cell phone with internet services.					
2	I enjoy studying Physical Sciences using a cell phone with internet services.					
3	Cell phones with internet services are fun, interesting and convenient in Physical Sciences learning.					
4	Cell phones with internet services help me to study Physical Sciences at my own pace and in my own time.					
5	I use my cell phone with internet services to read Physical Sciences before I get to class.					
6	I communicate Physical Sciences ideas with my friends using my cell phone.					
7	A cell phone with internet services helps me to understand Physical Sciences ideas better.					
8	Cell phones with internet services can help to improve					

	Physical Sciences performance.					
9	Cell phones with internet services improve communication between a learner and the educator.					
10	Cell phones with internet services are a quicker method of getting feedback in Physical Sciences.					
11	I do many Physical Sciences exercises through my cell phone with internet services.					
12	SMSs received from my teacher help me to study Physical Sciences better.					
13	I sometimes use the cell phone with internet services in class for things not related to learning.					
14	Cell phones with internet services cannot be used in Physical Sciences learning due to expenses involved.					
15	Cell phones with internet services learning cannot be used due to poor network in the villages.					
16	Cell phones with internet services learning cannot be used because it takes teachers' jobs.					
17	Most people who are important to me think that a cell phone with internet services improves my Physical Sciences performance.					

18	I enjoy participating in mobile Physical Sciences competitions.					
----	--	--	--	--	--	--

END OF QUESTIONNAIRE!

APPENDIX X
COVERING LETTER FOR EDUCATORS' QUESTIONNAIRE

Title of questionnaire: *Educators' perceptions of the use of cell phones in the teaching and learning of Physical Sciences.*

Dear Educator

This questionnaire forms part of my research study, entitled *Learners' and educators' perceptions of the use of cell phones in the teaching and learning of Physical Sciences in Moretele high schools of the Bojanala district*, for the degree of M. Ed. at the University of South Africa. You have been selected by a purposive sampling strategy from the population of Physical Sciences educators based on your use of cell phones with internet services for teaching and learning Physical Sciences. Hence, I invite you to take part in this survey.

The aim of this study is to investigate learners' and educators' perceptions of the use of cell phones with internet services in the teaching and learning of Physical Sciences. The findings of the study will benefit both learners and educators in coming up with the best ways to use cell phones with internet services in the teaching and learning of Physical Sciences.

You are kindly requested to complete this survey questionnaire, consisting of section A and section B, as honestly and frankly as possible and according to your personal views and experience. No foreseeable risks are associated with the completion of the questionnaire, which is for research purposes only. The questionnaire will take approximately 30 minutes to complete.

You are not required to indicate your name or organization and your anonymity will be ensured; however, indication of your age, gender, occupation, position etc. will contribute to a more comprehensive analysis. All information obtained from this questionnaire will be used for research purposes only and will remain confidential. Your participation in this survey is voluntary and you have the right to omit any question if so desired, or to withdraw from answering this survey without penalty at

any stage. After the completion of the study, an electronic summary of the findings of the research will be made available to you on request.

Permission to undertake this survey has been granted by the University of South Africa and the Ethics Committee of the College of Education, UNISA. If you have any research-related enquiries, they can be addressed directly to me or my supervisor, Professor N. Nkopodi of the Department of Education, UNISA. My contact details are 0738138203 and email 45362688@mylife.unisa.ac.za, and his are 0828554384 and email nkopon@unisa.ac.za.

By completing the questionnaire, you imply that you have agreed to participate in this research.

Please return the completed questionnaire to the assistant researcher at your school.

Thank you.

Yours sincerely



Godfrey C. Muyambi

Researcher

APPENDIX XI
QUESTIONNAIRE FOR TEACHERS

Section A

Instructions

- a) Do not write your name or name of school on the questionnaire.
- b) Please put a tick in the box provided to indicate your response to each question.
- c) You are kindly asked to answer all the questions.
- d) Note there are no correct or wrong answers to this questionnaire. However, your opinion is of great importance.

Please indicate your choice by means of a tick.

1. Gender 1. Male ☐ 2. Female ☐
2. Age ☐
1. Below 30 years ☐ 2. 31-35 years ☐
3. 36-40 years ☐ 4. 41-45 years ☐
5. Above 45 years ☐
3. Highest qualification in science:
1. ACE/Diploma ☐ 2. First degree ☐
3. Honours degree ☐ 4. Master's degree ☐ Other ☐
4. Do you have a cell phone with an internet service?
1. Yes ☐ 2. No ☐
5. Do you use a cell phone with internet services for Physical Sciences teaching?
1. Yes ☐ 2. No ☐
6. If "Yes", how many times in a week do you use a cell phone programme to help your Physical Sciences learners?
1. 1-2 times ☐ 2. 3-4 times ☐
3. 5 or more times ☐

7. How many times do you send SMS comments to your learners per week?

1. 1-2 times ☐ 2. 3-4 times ☐
 3. 5 or more times ☐

8 a) Do you think cell phones with internet services help your learners to pass Physical Sciences?

1. Yes ☐ 2. No ☐ 3. Not sure ☐

b) If “Yes”, explain your answer. -----

10 a) Do you think cell phones with internet services should be used for Physical Sciences learning in all schools?

1. Yes ☐ 2. No ☐ 3. Not sure ☐

b) If “Yes”, give your reasons. -----

11 a).Do you think cell phones with internet services can cause indiscipline in Schools?

1. Yes ☐ 2. No ☐ 3. Not sure ☐

b) If “Yes”, give your reasons. -----

Section B

Listed below are statements that require your opinion on Physical Sciences cell-phone programmes. Please answer by ticking either 1, 2, 3, 4 or 5 to indicate your choice.

1=Strongly disagree; 2=Disagree; 3=Undecided; 4=Agree; 5=Strongly agree

	Question	Strongly agree [5]	Agree [4]	Undecided [3]	Disagree [2]	Strongly disagree [1]
1	I have a good knowledge of the use of cell phones with internet services.					
2	I enjoy reading Physical Sciences using a cell phone					

	with internet services.					
3	Cell phones with internet services are fun, interesting and convenient in Physical Sciences teaching and learning.					
4	Cell phones with internet services help learners to understand Physical Sciences concepts better.					
5	Cell phones with internet service programmes give learners the opportunity to study Physical Sciences at their own pace anywhere and at any time.					
6	I always communicate with my Physical Sciences learners with my cell phone.					
7	Mobile Physical Sciences is an effective and efficient method of learning Physical Sciences.					
8	Cell phones with internet services can improve Physical Sciences performance.					
9	Cell phone programmes give me more time to help my Physical Sciences learners.					
10	A cell phone with internet services is a quicker method of getting feedback in Physical Sciences.					

11	Learners do many Physical Sciences exercises because cell phones with internet services are interesting to them.					
12	Cell phones with internet services improve communication between a learner and the educator.					
13	Cell phones with internet services cannot be used due to unavailability of cell phones to learners.					
14	Cell phones with internet services cannot be used due to expenses involved in mobile learning.					
15	Cell phones with internet services cannot be used due to poor network in the villages.					
17	Cell phones with internet services cannot be used due to abuse by learners in the schools.					
18	Cell phones with internet services cannot be used because this takes teachers' jobs.					
19	I enjoy participating in Physical Sciences cell-phone learning and teaching.					

END OF QUESTIONNAIRE!

THANK YOU ONCE AGAIN FOR YOUR PARTICIPATION IN THIS STUDY.

NB: An abstract of the results will be sent to you upon your request.

APPENDIX XII
COVERING LETTER FOR FOCUS-GROUP INTERVIEW SCHEDULE FOR
THE LEARNERS

Title of focus-group interview: *Learners' perceptions of the use of cell phones in the teaching and learning of Physical Sciences.*

Dear Respondent

This interview forms part of my research study, entitled *Learners' and educators' perceptions of the use of cell phones in the teaching and learning of Physical Sciences in Moretele high schools of the Bojanala district*, for the degree of M. Ed. at the University of South Africa. You have been selected by a purposive sampling strategy from the population of Physical Sciences learners based on your use of cell phones with internet services for learning Physical Sciences. Hence, I invite you to take part in this survey.

The aim of this study is to investigate learners' and educators' perceptions of the use of cell phones with internet services in the teaching and learning of Physical Sciences. The findings of the study will benefit both learners and educators in coming up with the best ways to use cell phones with internet services in the teaching and learning of Physical Sciences.

You are kindly requested to answer questions I am going to ask you as honestly and frankly as possible and according to your personal or group views and experience. There are no foreseeable risks associated with the answering of the questions I will pose to you, which are for research purposes only. The interview will take approximately 15 minutes to complete.

You are not required to indicate your name or school and your anonymity will be ensured. While every effort will be made by the researcher to ensure that you will not be connected to the information that you share during the focus group, I cannot guarantee that other participants in the focus group will treat information

confidentially, though I am encouraging all participants to do so. For this reason I advise you not to disclose personally sensitive information in the focus group.

All information obtained from this interview will be used for research purposes only and will remain confidential. Your participation in this survey is voluntary and you have the right to omit any question if so desired, or to withdraw from answering this survey without penalty at any stage. After the completion of the study, an electronic summary of the findings of the research will be made available to you on request.

Permission to undertake this survey has been granted by the University of South Africa and the Ethics Committee of the College of Education, UNISA. If you have any research-related enquiries, they can be addressed directly to me or my supervisor, Professor N. Nkopodi of the Department of Education, UNISA. My contact details are 0738138203 and email 45362688@mylife.unisa.ac.za, and his are 0828554384 and email nkopon@unisa.ac.za.

By responding to my questions here, you imply that you have agreed to participate in this research.

Please feel free and answer my questions truthfully and honestly.

Thank you.

Yours sincerely



Godfrey C. Muyambi

Researcher

APPENDIX XIII

FOCUS-GROUP INTERVIEW SCHEDULE FOR THE LEARNERS

Title of focus-group interview schedule: *Learners' perceptions of the use of cell phones in the teaching and learning of Physical Sciences.*

Questions

1. What is good about using cell phones with internet services in learning Physical Sciences?
2. What is bad about using cell phones with internet services in learning Physical Sciences?
3. Do you think cell phones with internet services should be used for the teaching and learning of Physical Sciences in all schools? Please support your answer.

APPENDIX XIV
COVERING LETTER FOR EDUCATORS' INTERVIEW

Title of interview: *Educators' perceptions of the use of cell phones in the teaching and learning of Physical Sciences.*

Dear Educator

This interview forms part of my research study, entitled *Learners' and educators' perceptions of the use of cell phones in the teaching and learning of Physical Sciences in Moretele high schools of the Bojanala district*, for the degree of M. Ed. at the University of South Africa. You have been selected by a purposive sampling strategy from the population of Physical Sciences educators based on your use of cell phones with internet services for teaching and learning Physical Sciences. Hence, I invite you to take part in this survey.

The aim of this study is to investigate learners' and educators' perceptions of the use of cell phones with internet services in the teaching and learning of Physical Sciences. The findings of the study will benefit both learners and educators in coming up with the best ways to use cell phones in the teaching and learning of Physical Sciences.

You are kindly requested to answer questions as honestly and frankly as possible according to your personal views and experience. There are no foreseeable risks associated with this interview, which is for research purposes only. The interview will take approximately 15 minutes to complete.

Every effort will be made by the researcher to ensure that you will not be connected to the information that you share during the interview. Your name or school and your anonymity will be ensured.

All information obtained from this interview will be used for research purposes only and will remain confidential. Your participation in this survey is voluntary and you have the right to omit any question if so desired, or to withdraw from answering this

survey without penalty at any stage. After the completion of the study, an electronic summary of the findings of the research will be made available to you on request.

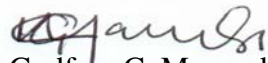
Permission to undertake this survey has been granted by the University of South Africa and the Ethics Committee of the College of Education, UNISA. If you have any research-related enquiries, they can be addressed directly to me or my supervisor, Professor N. Nkopodi of the Department of Education, UNISA. My contact details are 0738138203 and email 45362688@mylife.unisa.ac.za, and his are 0828554384 and email nkopon@unisa.ac.za.

By responding to my questions in this schedule, you imply that you have agreed to participate in this research.

Please feel at home and answer questions I am going to ask you honestly and frankly.

Thank you.

Yours sincerely



Godfrey C. Muyambi

Researcher

APPENDIX XV
INTERVIEW SCHEDULE FOR THE EDUCATORS

Title of interview: *Educators' perceptions of the use of cell phones in the teaching and learning of Physical Sciences.*

Questions

1. What is good about using cell phones with internet services in the teaching and learning of Physical Sciences?
2. What is bad about using cell phones with internet services in the teaching and learning of Physical Sciences?
3. Do you think cell phones with internet services should be used in the learning and teaching of Physical Sciences in all schools?
4. How can we best implement cell-phone learning and teaching in Physical Sciences?

APPENDIX XVI



Research Ethics Clearance Certificate

This is to certify that the application for ethical clearance submitted by

GC Muyambi [45362688]

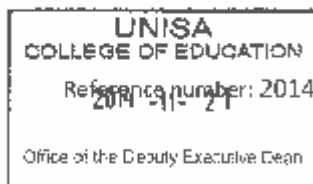
for a MEd study entitled

Learners and educators' perceptions of the use of cell phones in teaching and learning of Physical Sciences in Moretele Area office high schools of Bojanala district in South Africa

has met the ethical requirements as specified by the University of South Africa College of Education Research Ethics Committee. This certificate is valid for two years from the date of issue.

Prof VI McKay
Acting Executive Dean: CEDU

Dr M Claassens
CEDU REC (Chairperson)
mcdtc@netactive.co.za



17 NOVEMBER 2014

APPENDIX XVII



education

Letapisa la Thuto
Onderwys Departement
Department of Education
NORTH WEST PROVINCE

Private Bag X365
Mokopane 0454
Tel: (012) 714-0360
Tel: (012) 714-2764
Fax: (012) 714-2366

OFFICE OF THE AREA MANAGER: MORETELE AREA PROJECT OFFICE

Enquiries: Letswalo, H.M.
Cell: 083 408 9913

To: Mr. Godfrey C. Moyambi

From: Letswalo, H. M.
Circuit Manager


Date: 10 October 2013

Subject: Request for administering research instrument

As afore referred you are granted permission to make a research in our schools however we ask you to keep to ethics thereof. May we be favoured with the findings of the report?

Hope you find this in order.

Thanks.


Mosebe, M. K. Z.
(Area Manager)

